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**Zeiler et al.**

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(54) **MOWER DECK INSERT**

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(73) Assignee: **Briggs & Stratton, LLC**, Wauwatosa, WI (US)

(\*) Notice: Subject to any disclaimer, the term of this patent is extended or adjusted under 35 U.S.C. 154(b) by 257 days.

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**Related U.S. Application Data**

(63) Continuation of application No. 15/430,304, filed on Feb. 10, 2017, now abandoned, which is a (Continued)

(51) **Int. Cl.**

**A01D 34/81** (2006.01)

**A01D 34/00** (2006.01)

(Continued)

(52) **U.S. Cl.**

CPC ..... **A01D 34/81** (2013.01); **A01D 34/005** (2013.01); **A01D 34/664** (2013.01);

(Continued)

(58) **Field of Classification Search**

CPC .... A01D 34/81; A01D 34/005; A01D 34/664; A01D 34/667; A01D 34/71; A01D 34/823; A01D 34/73

See application file for complete search history.

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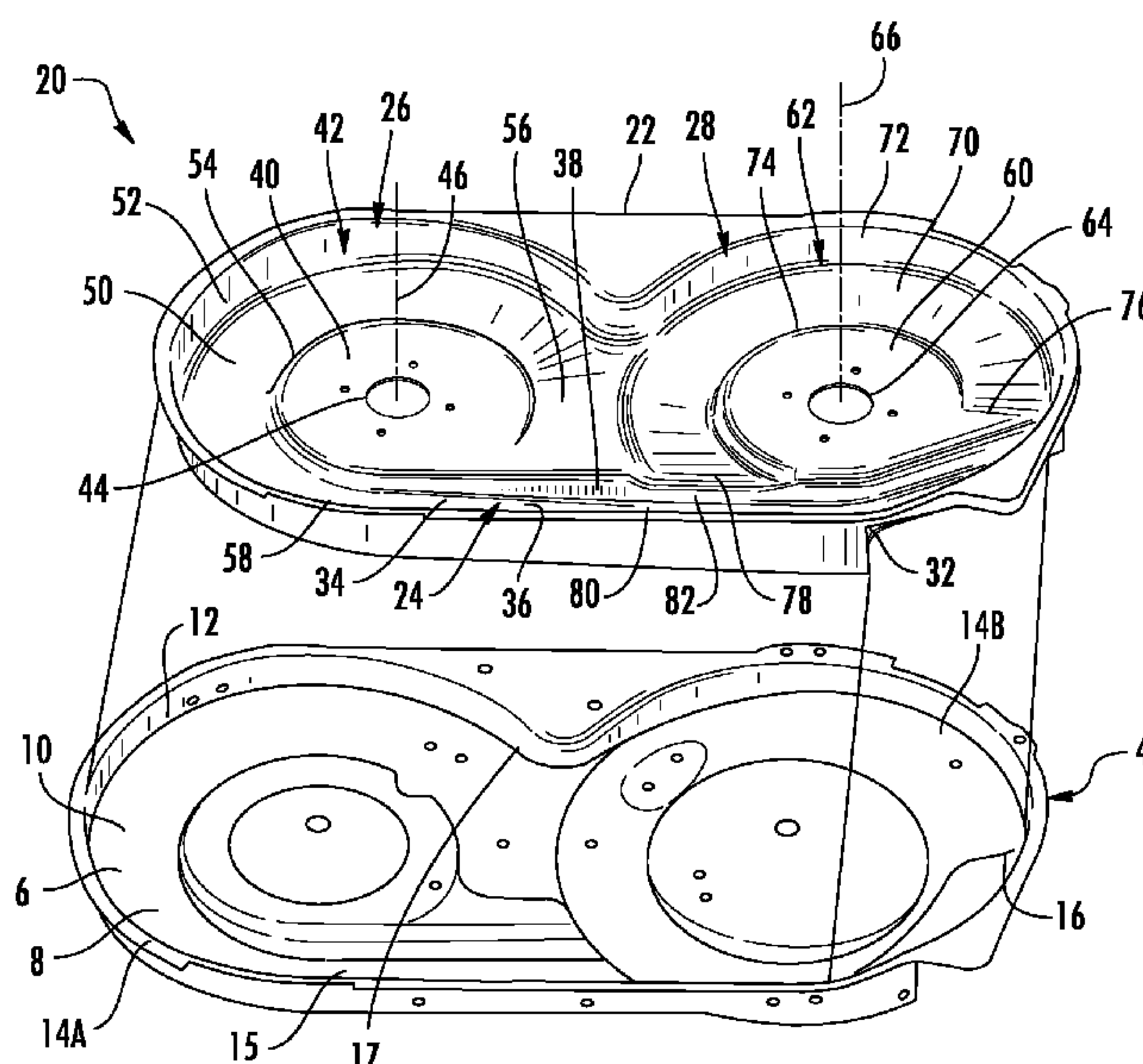
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(57) **ABSTRACT**

A mower deck insert includes a first cutting chamber, a second cutting chamber, and a discharge passage extending adjacent to the first cutting chamber and the second cutting chamber. The first cutting chamber includes a first axial scroll extending about a first vertical axis. The first axial scroll includes a first upper surface having a first start region and a first end region. The second cutting chamber includes a second axial scroll extending about a second vertical axis. The second axial scroll includes a second upper surface having a second start region and a second end region. The first start region is vertically lower than the first end region, and the second start region is vertically lower than the second end region.

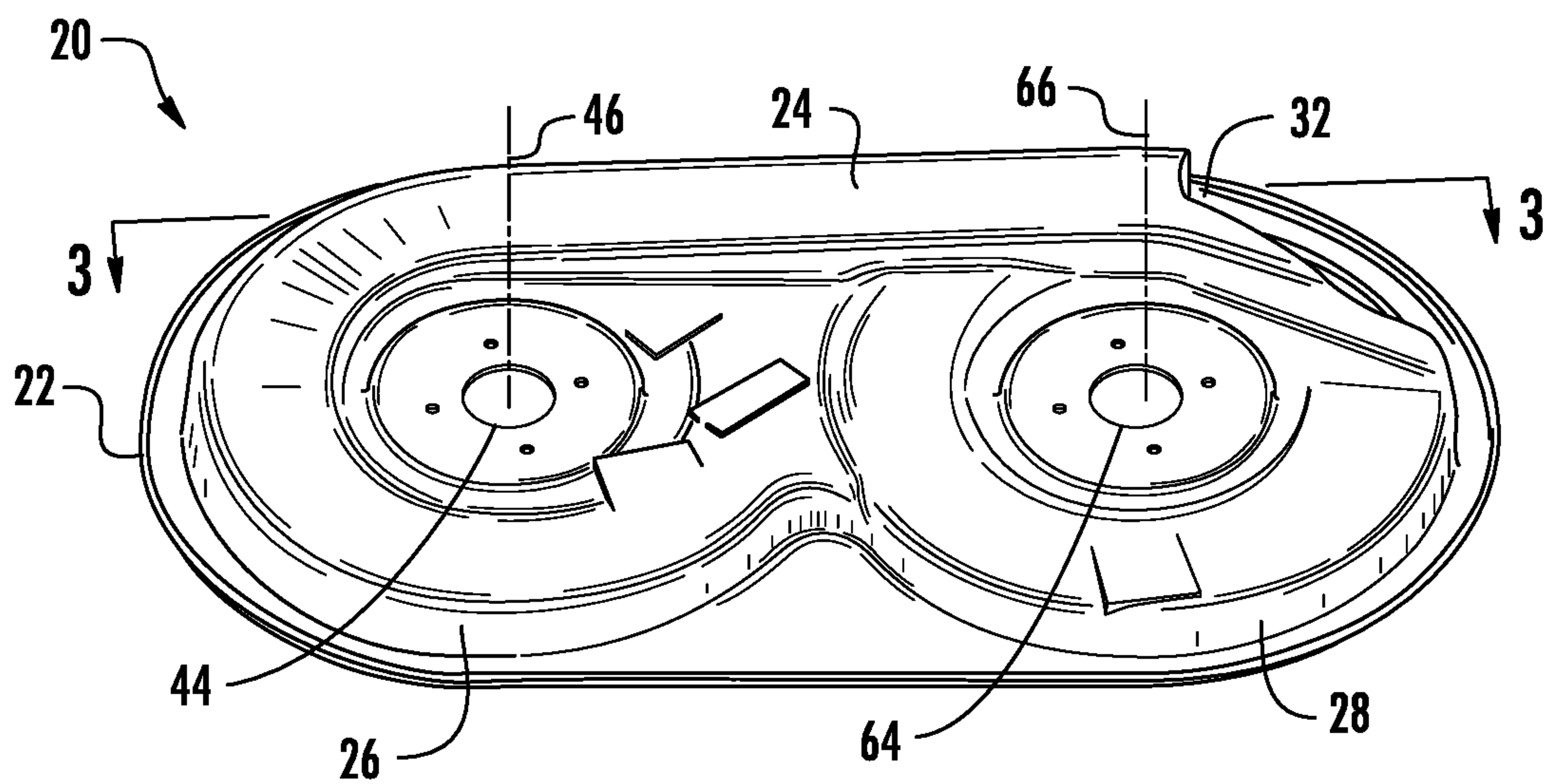
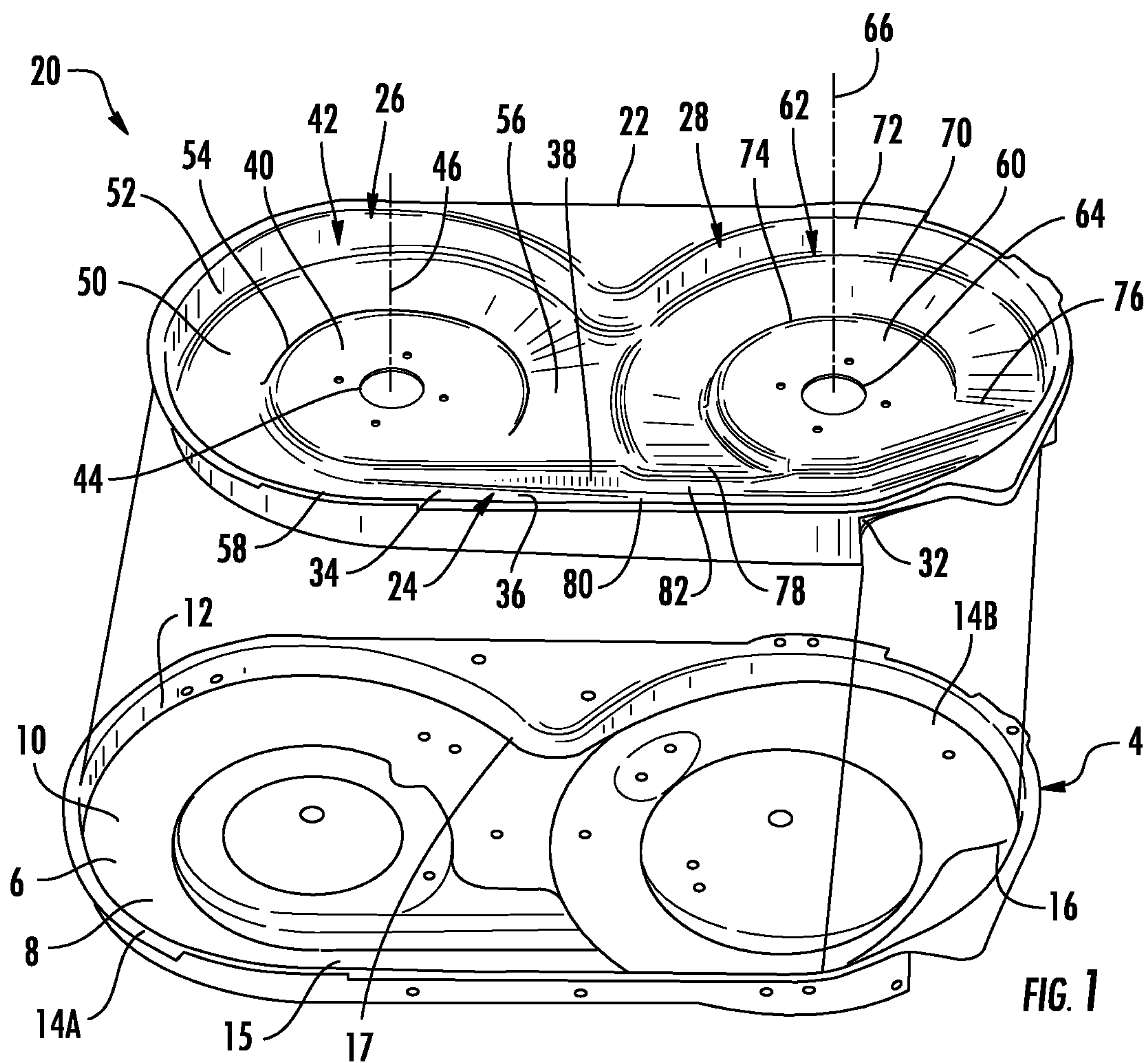
**20 Claims, 23 Drawing Sheets**

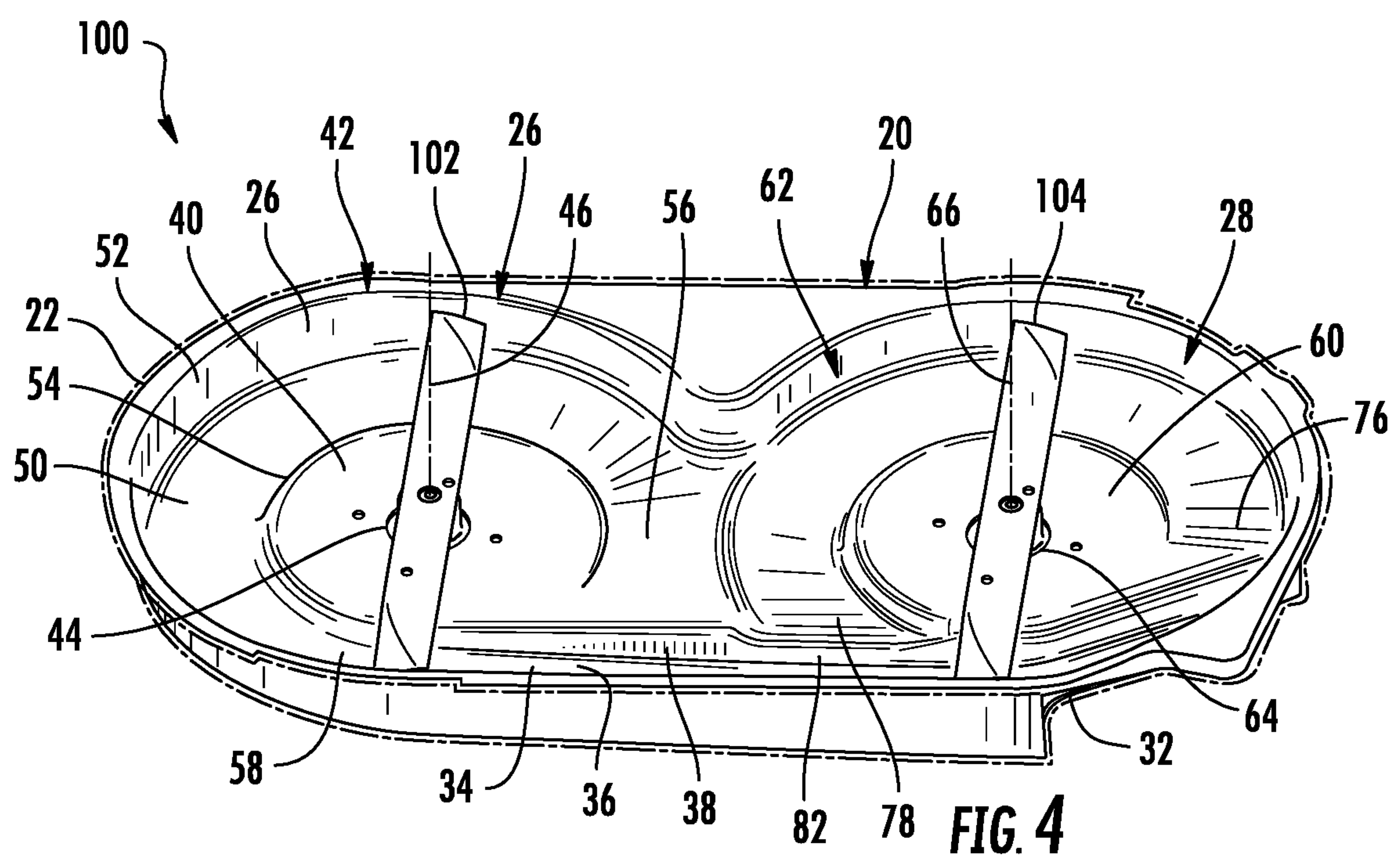
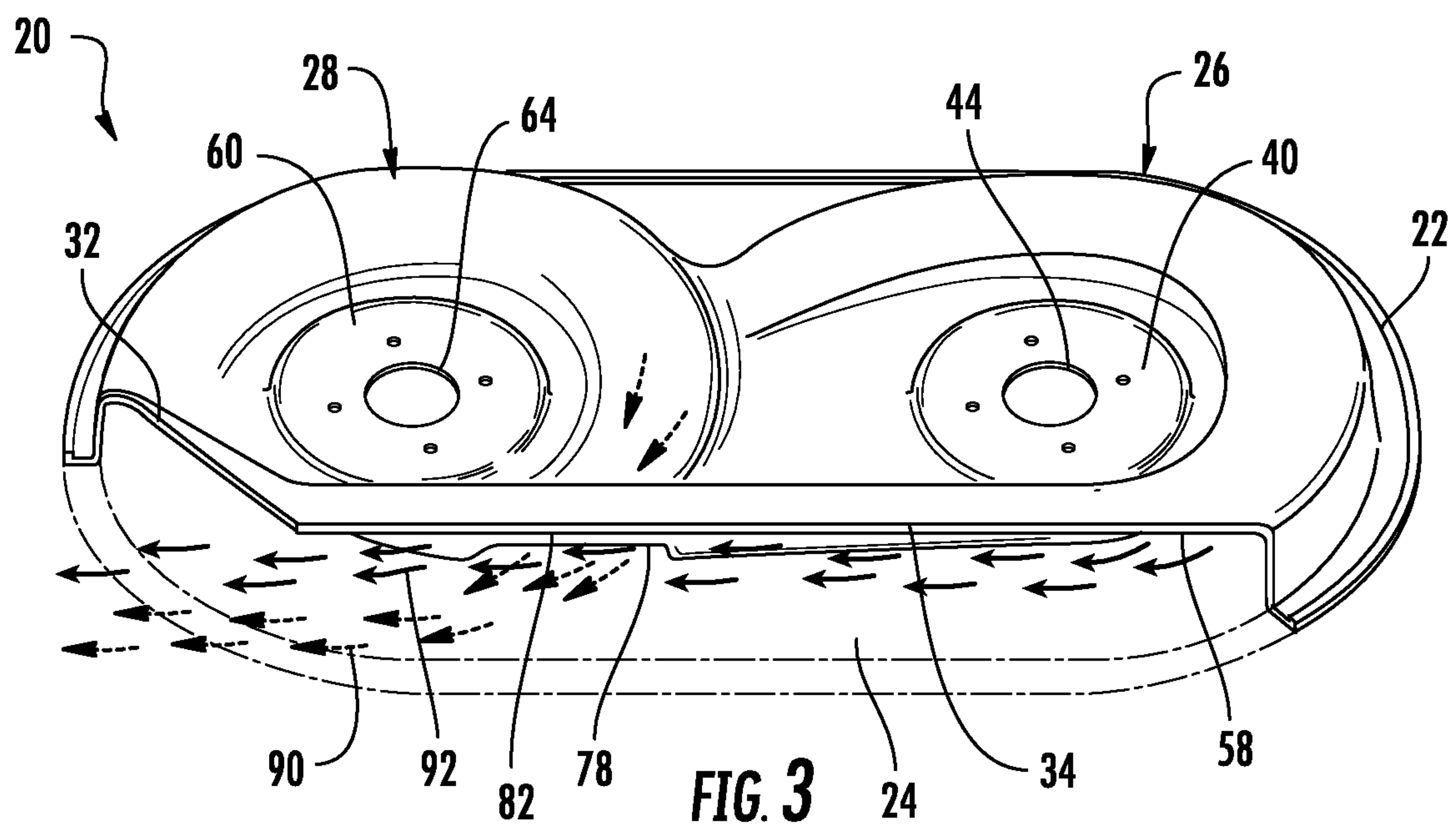


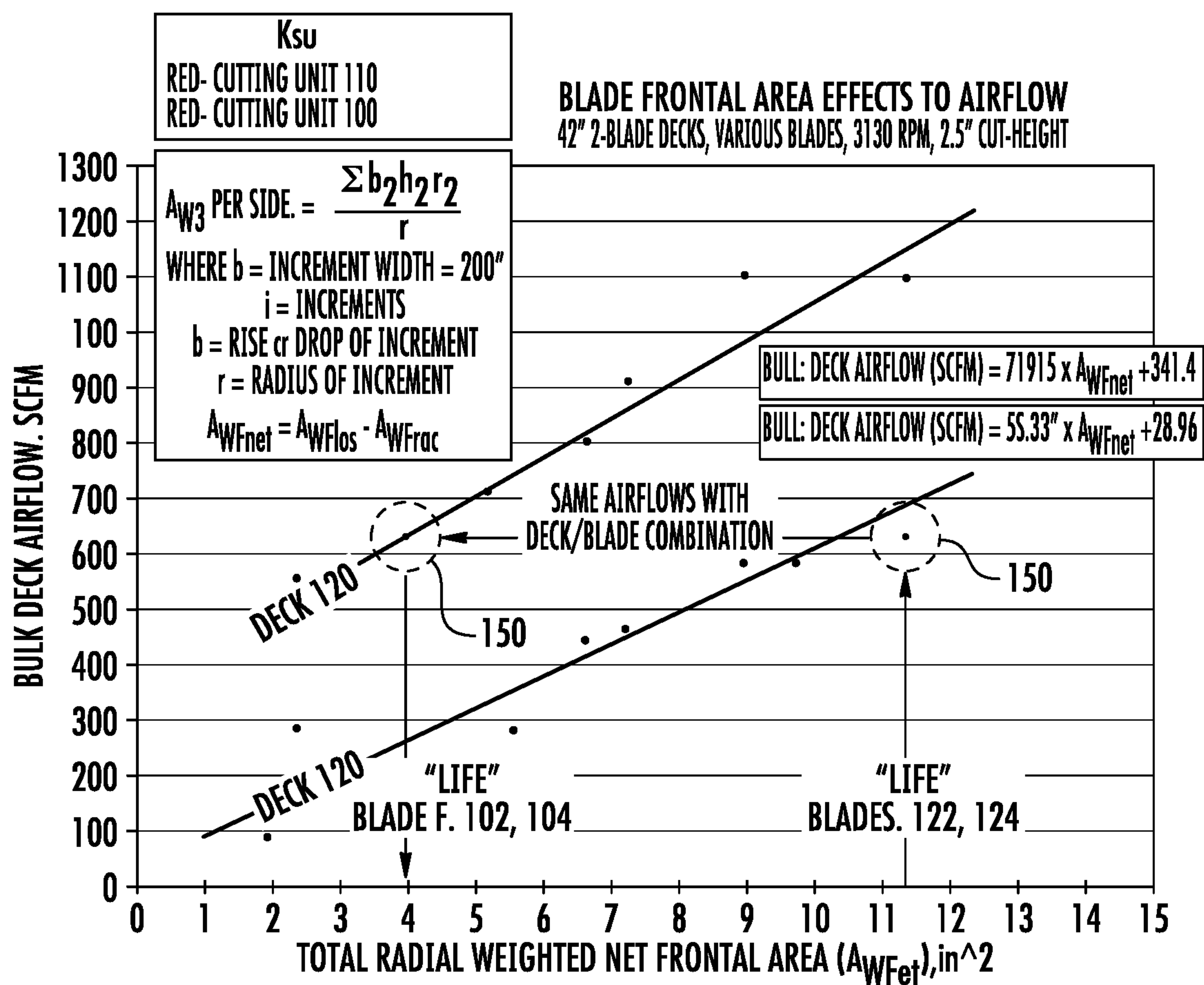
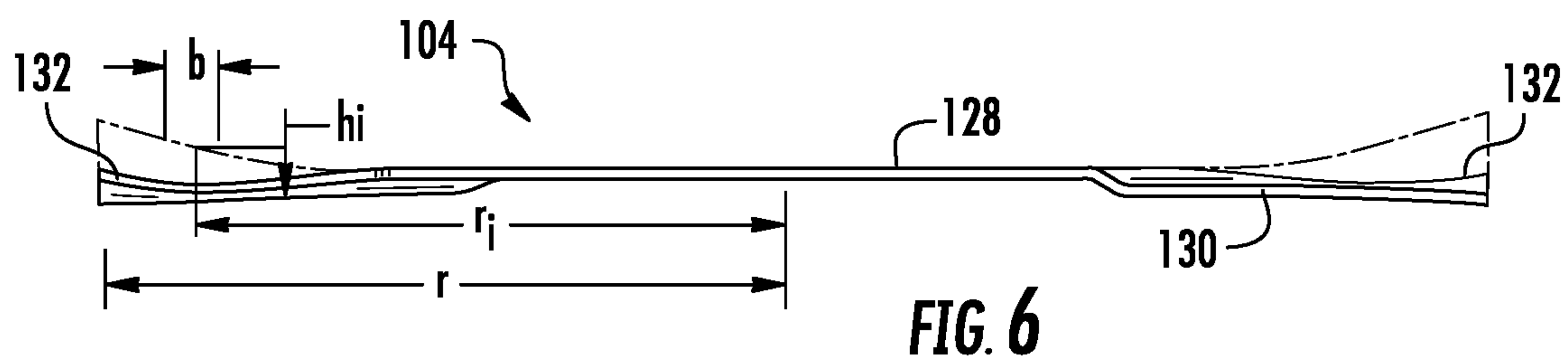
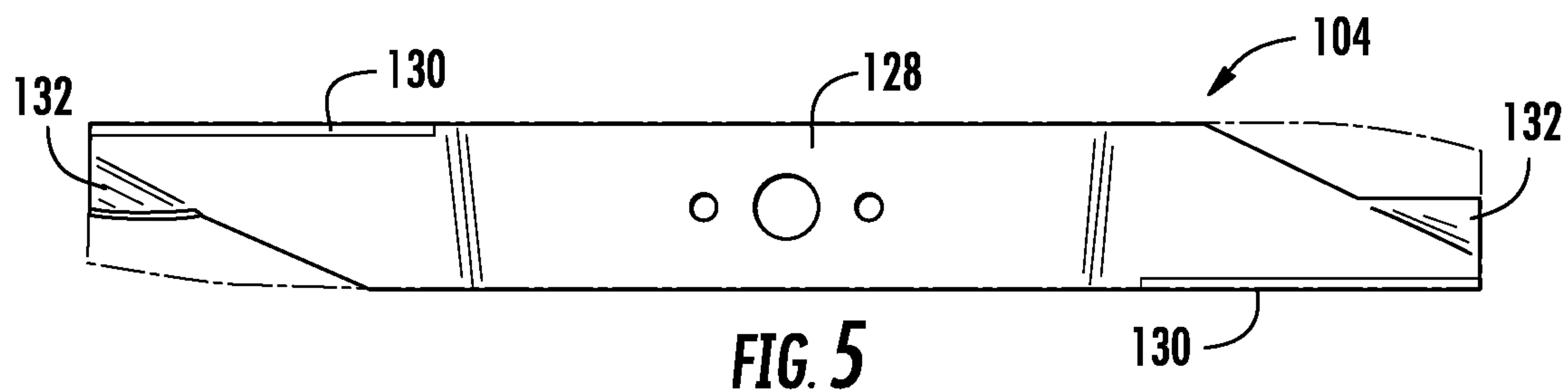
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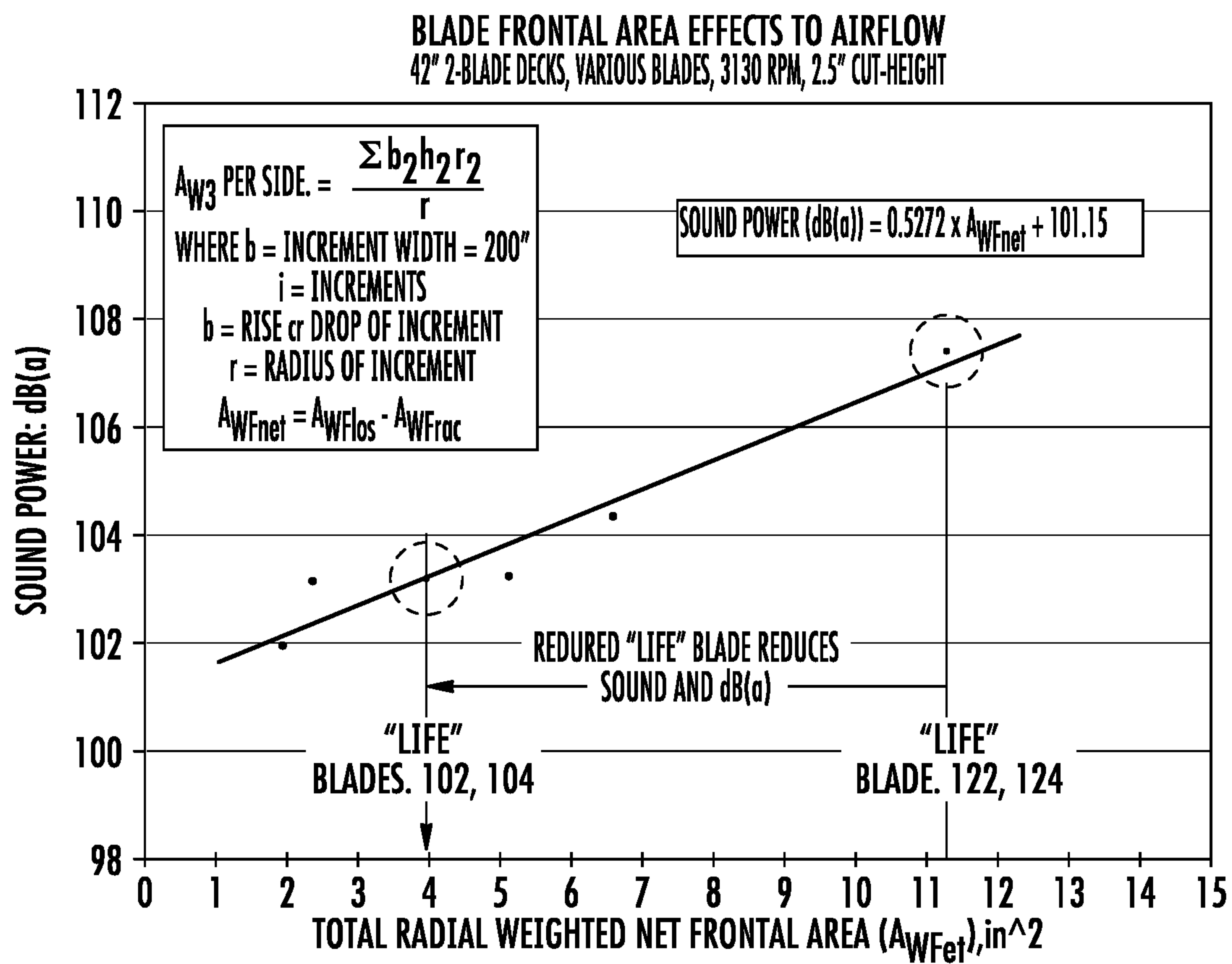


FIG. 8

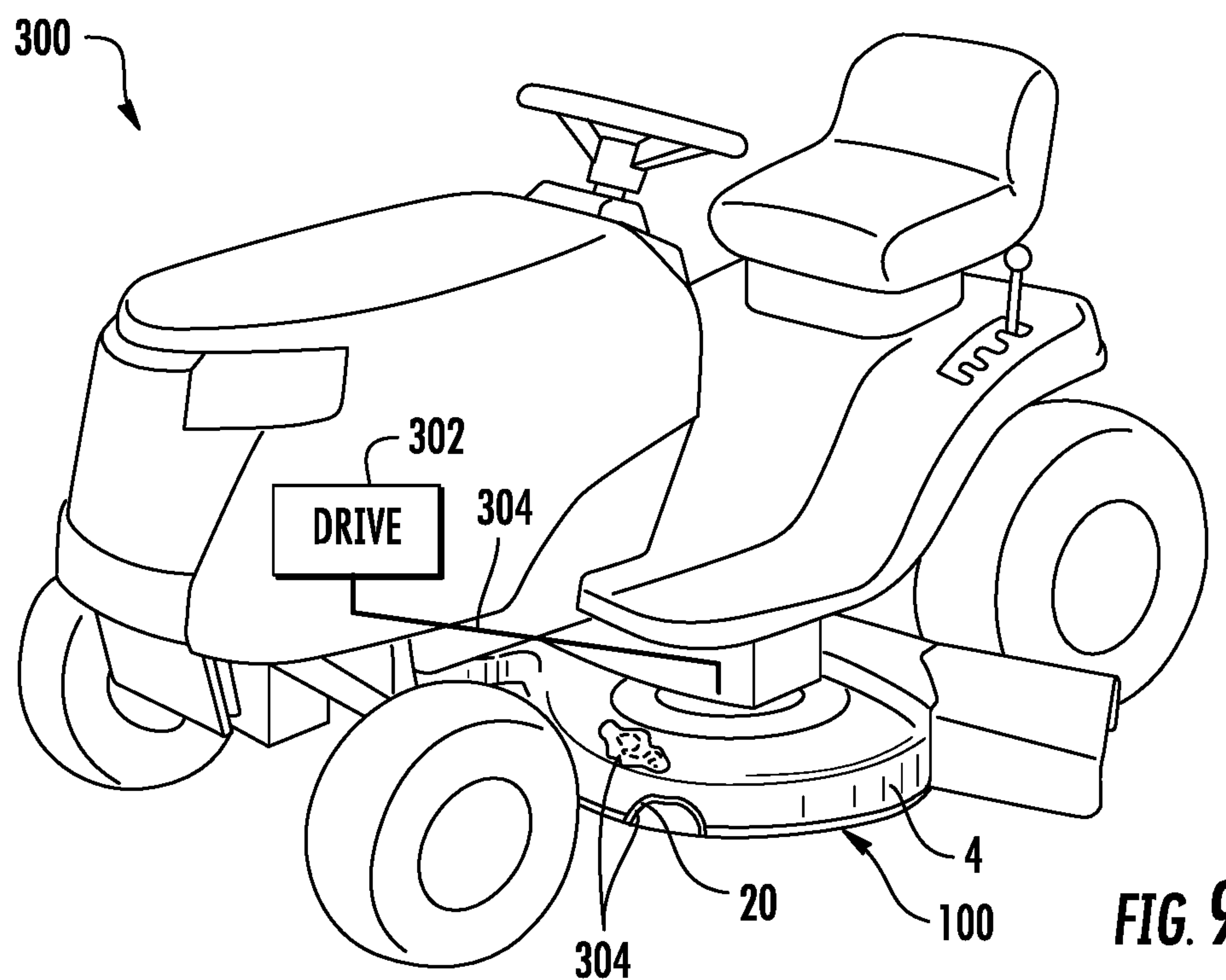


FIG. 9



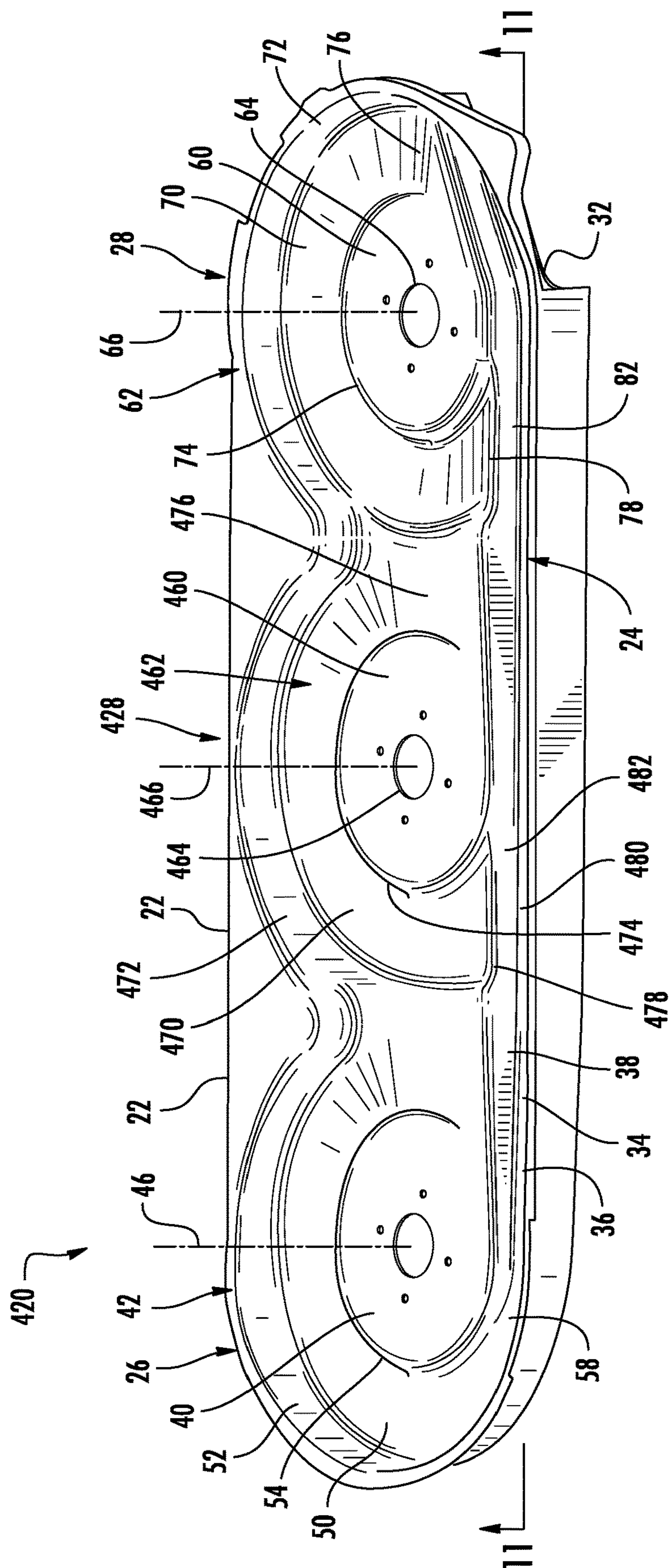
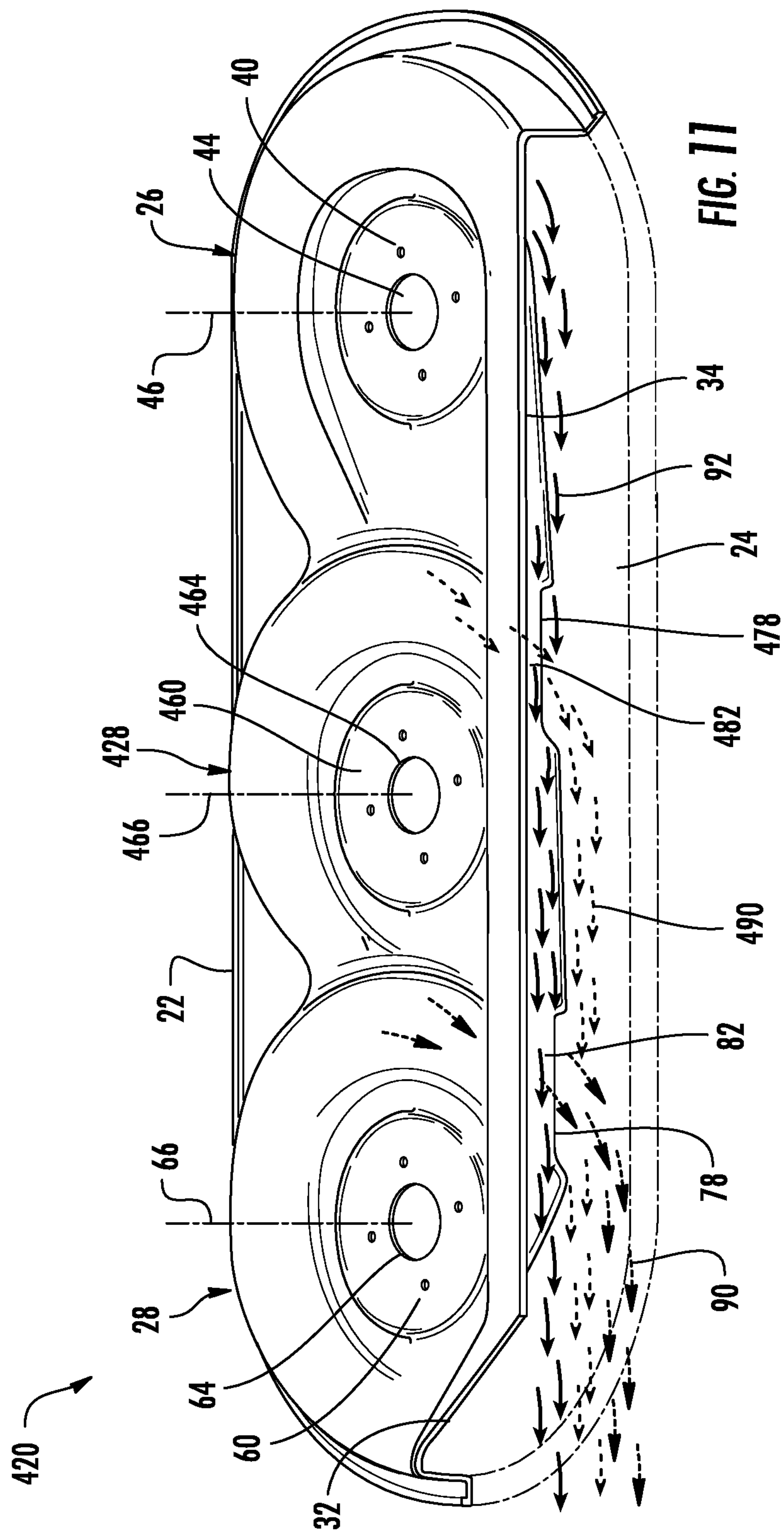
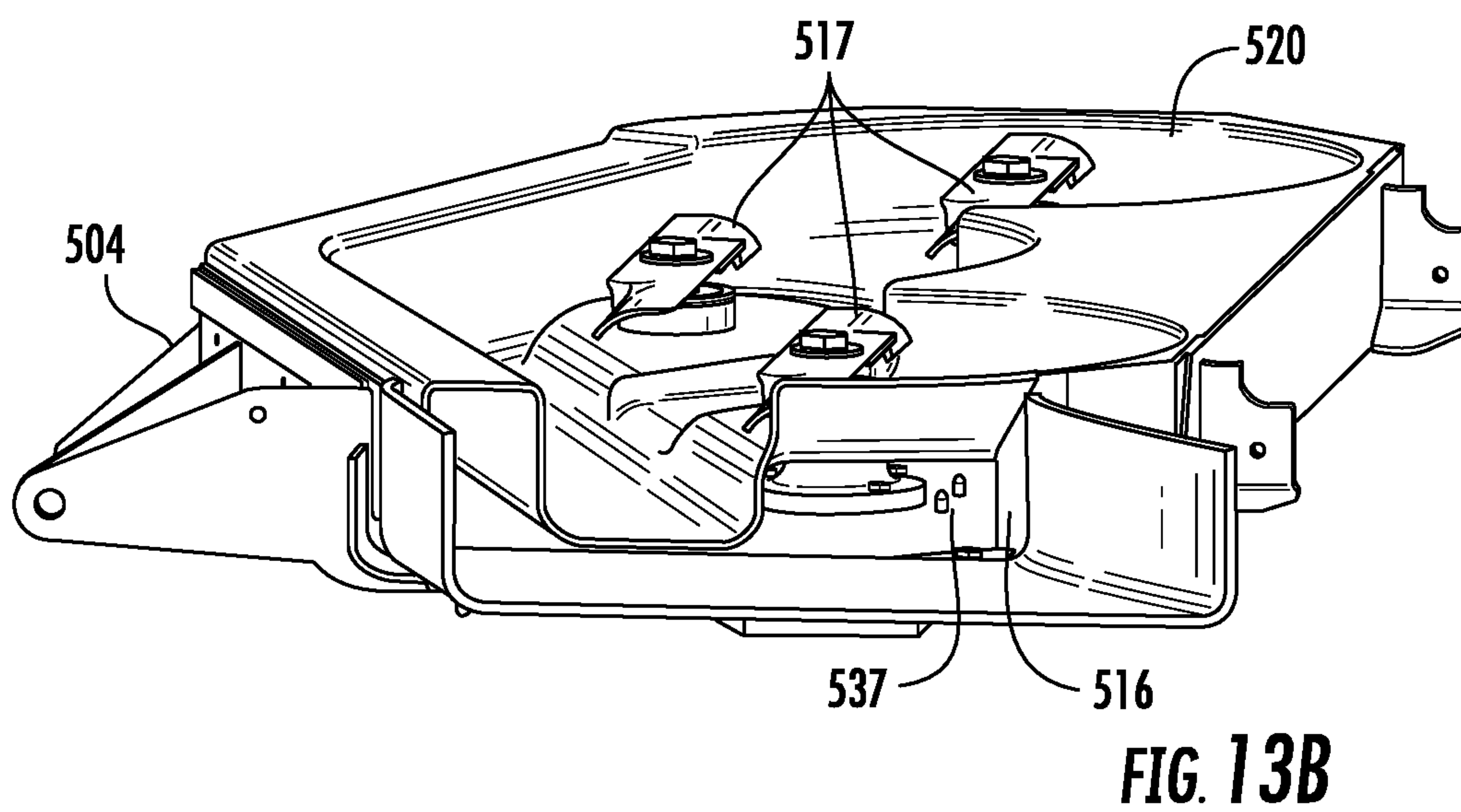
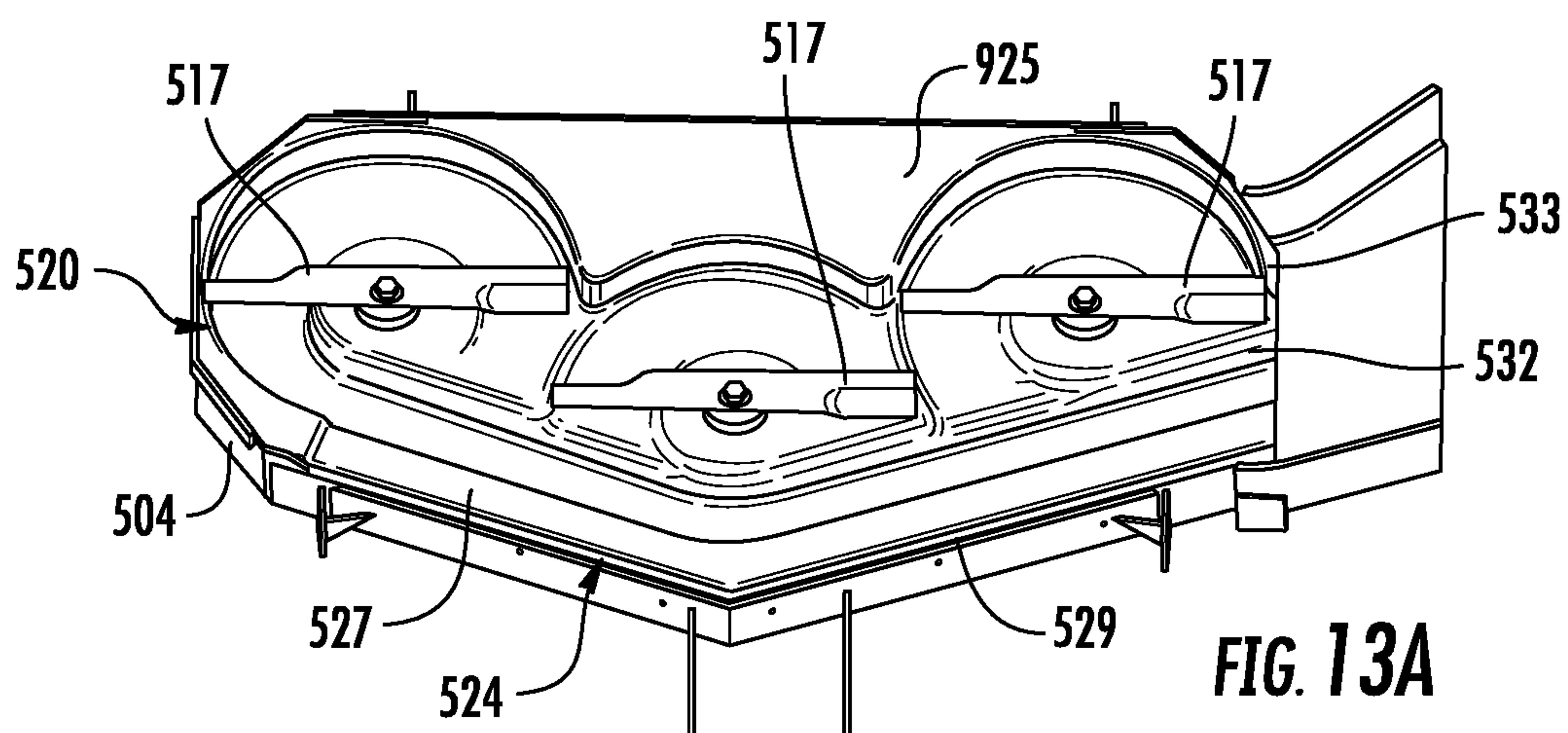
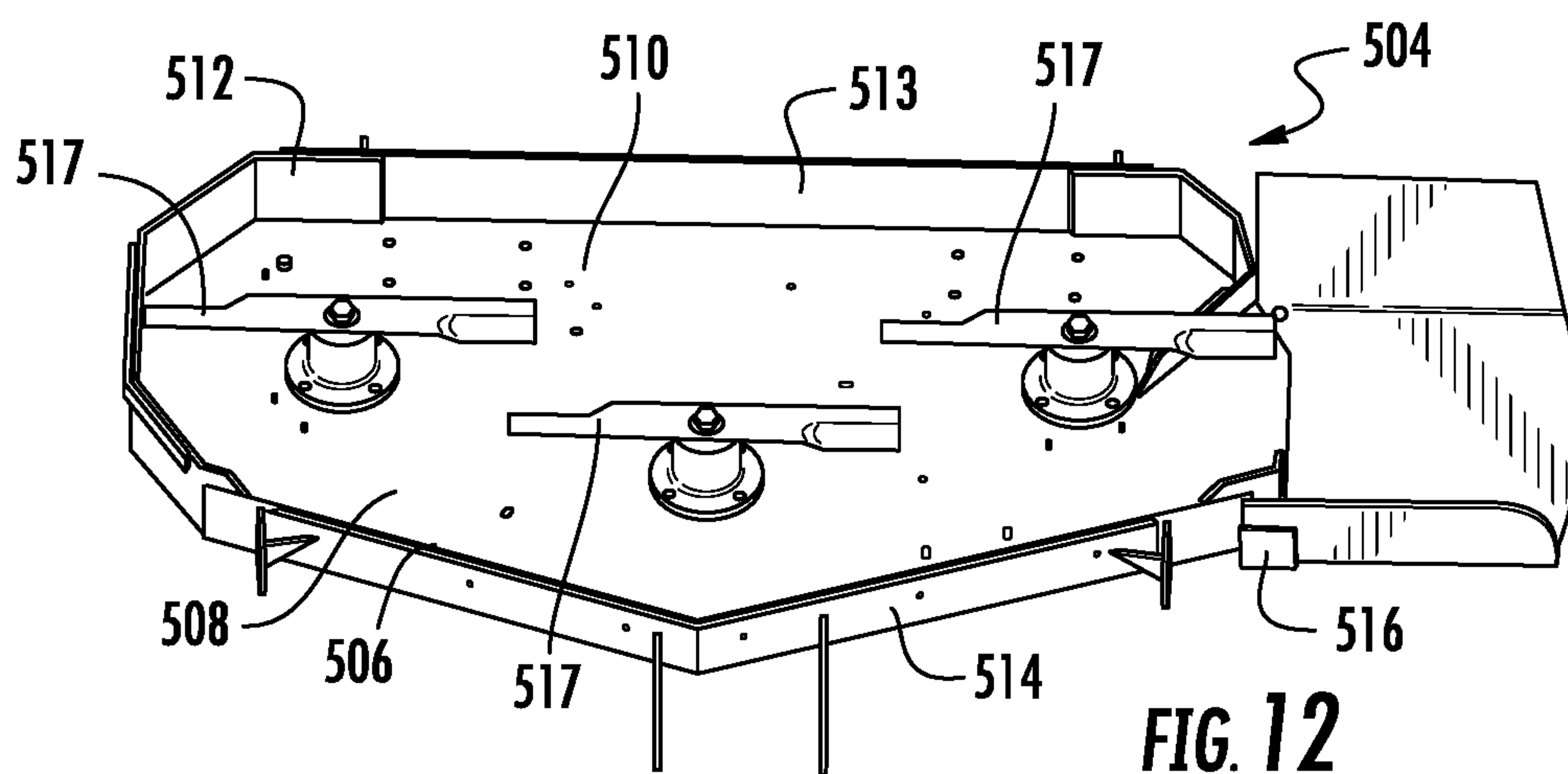
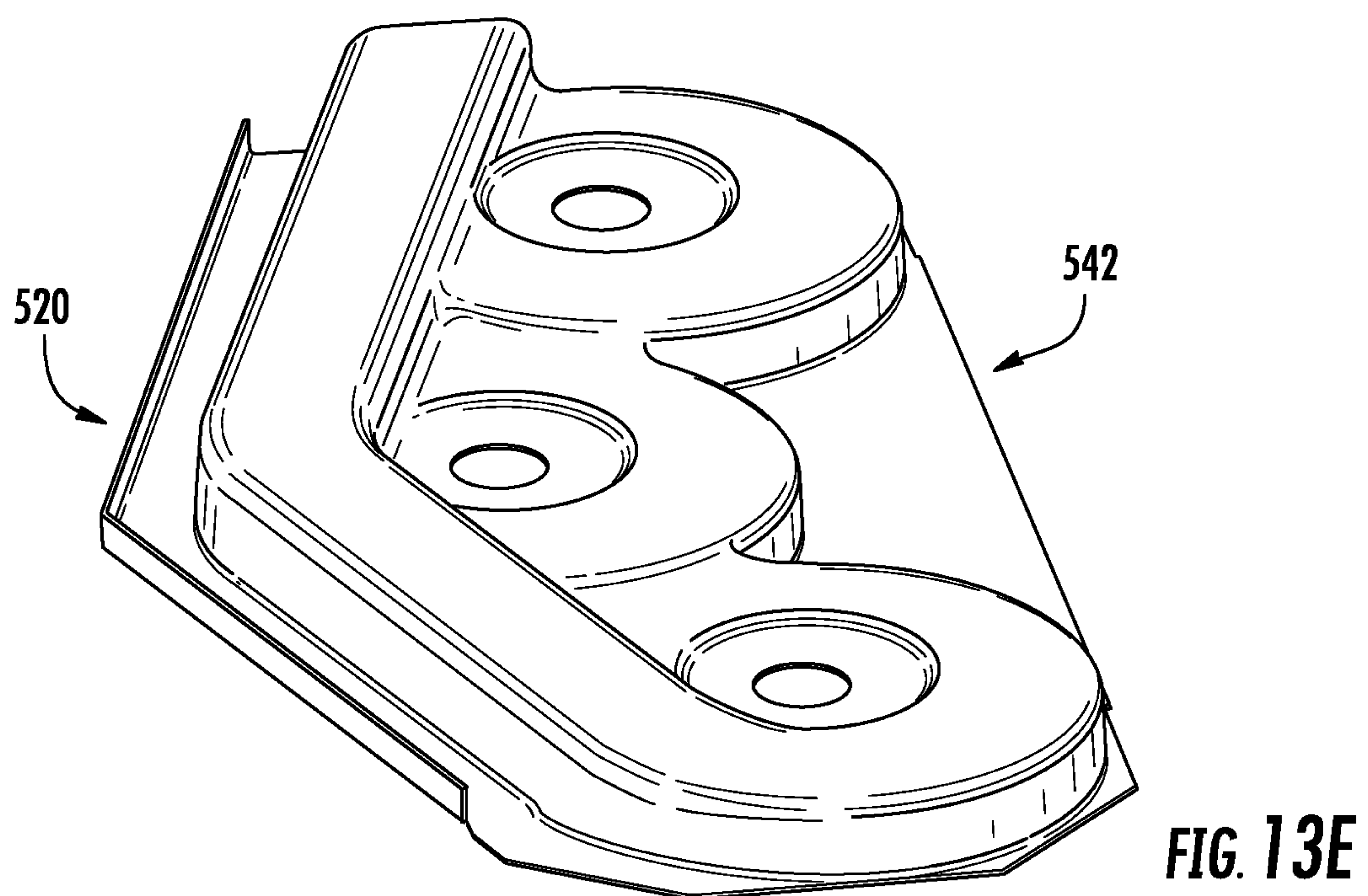
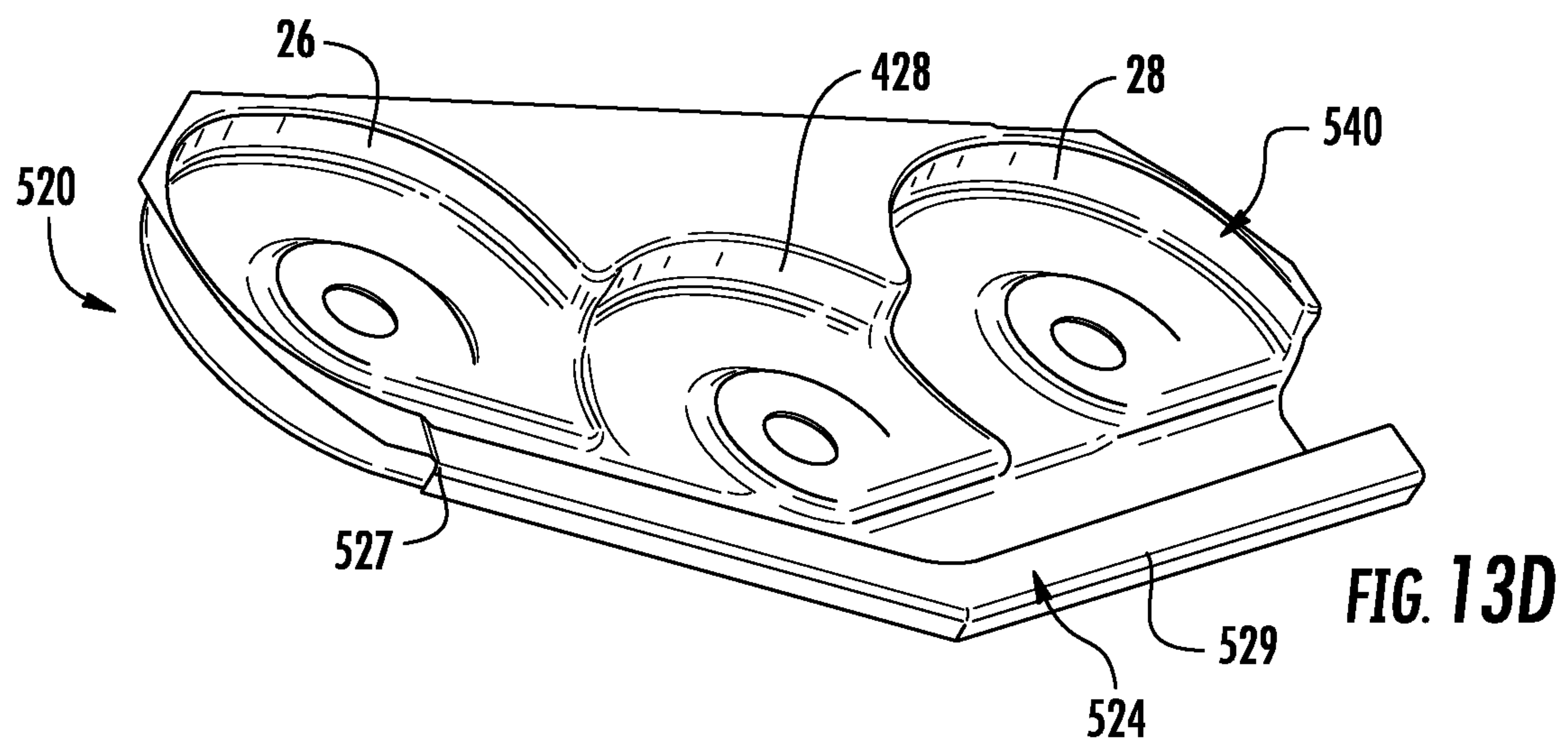
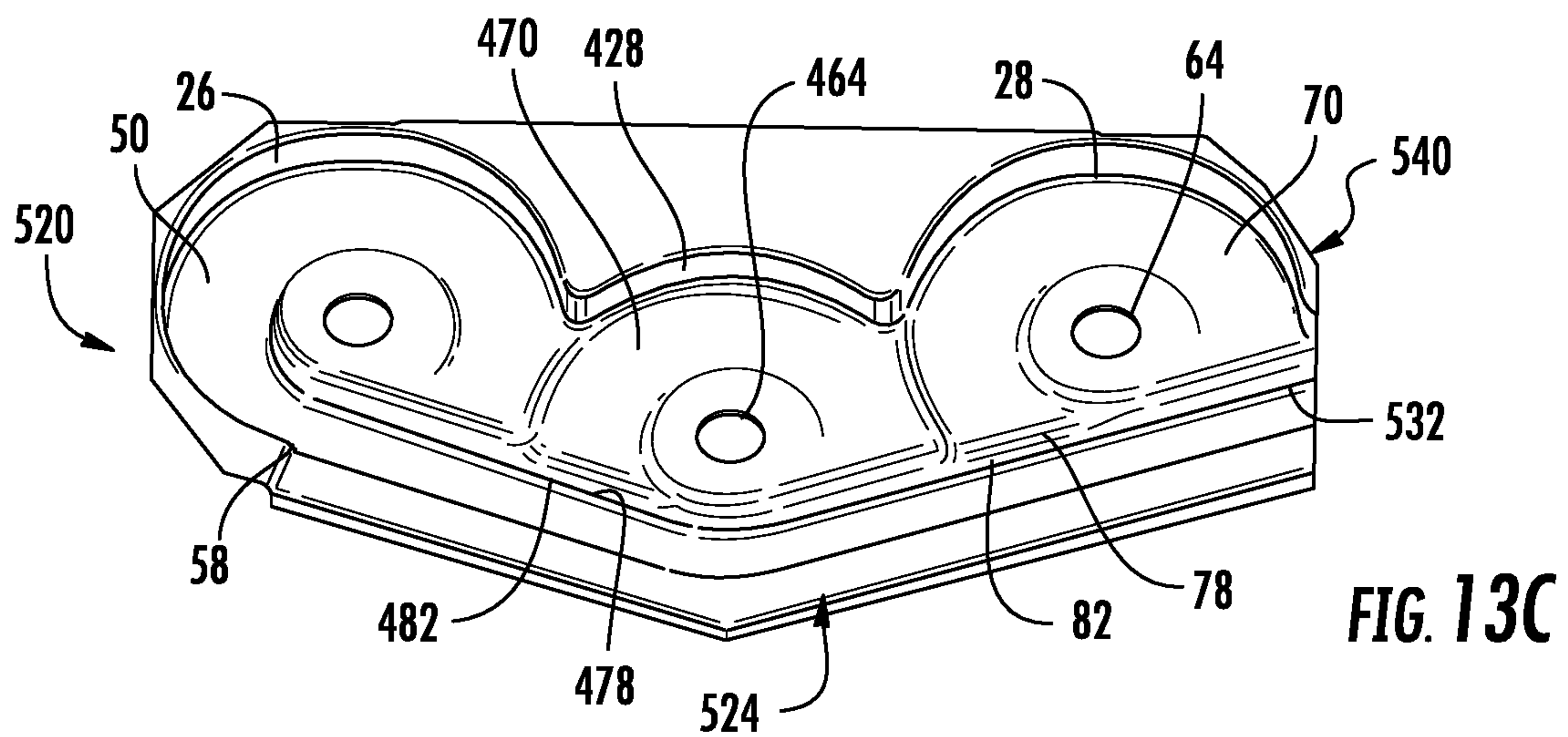


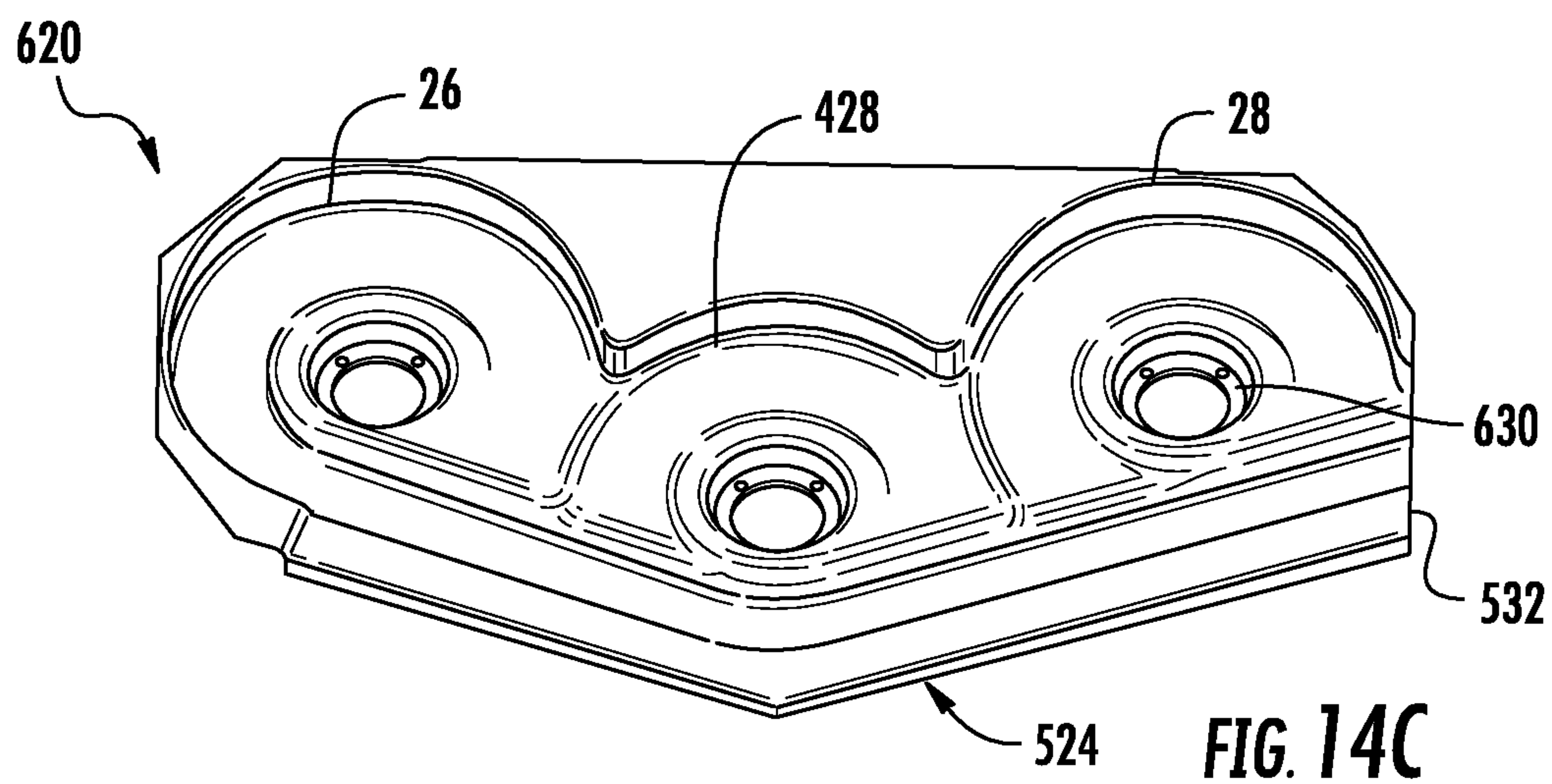
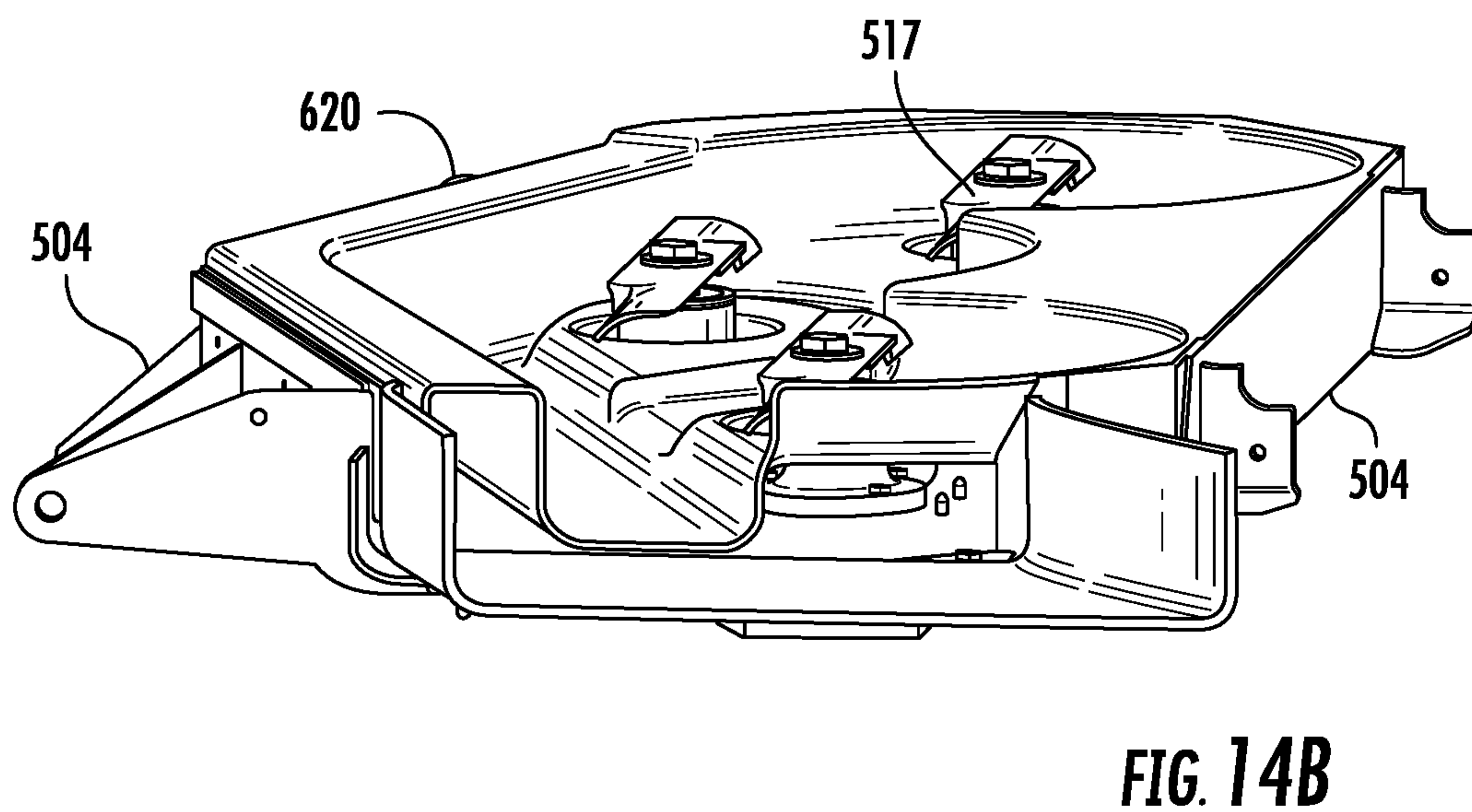
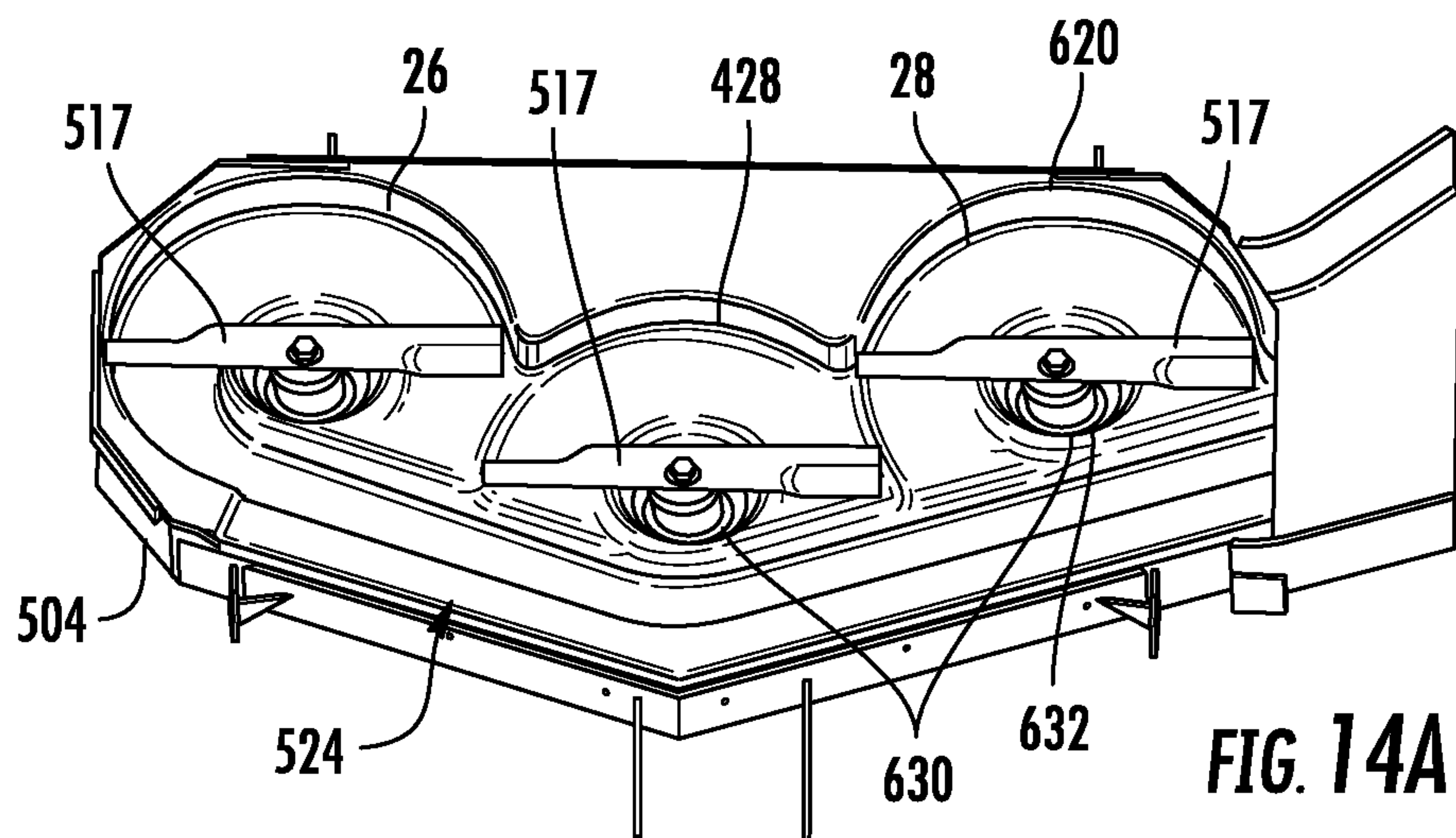
FIG. 10



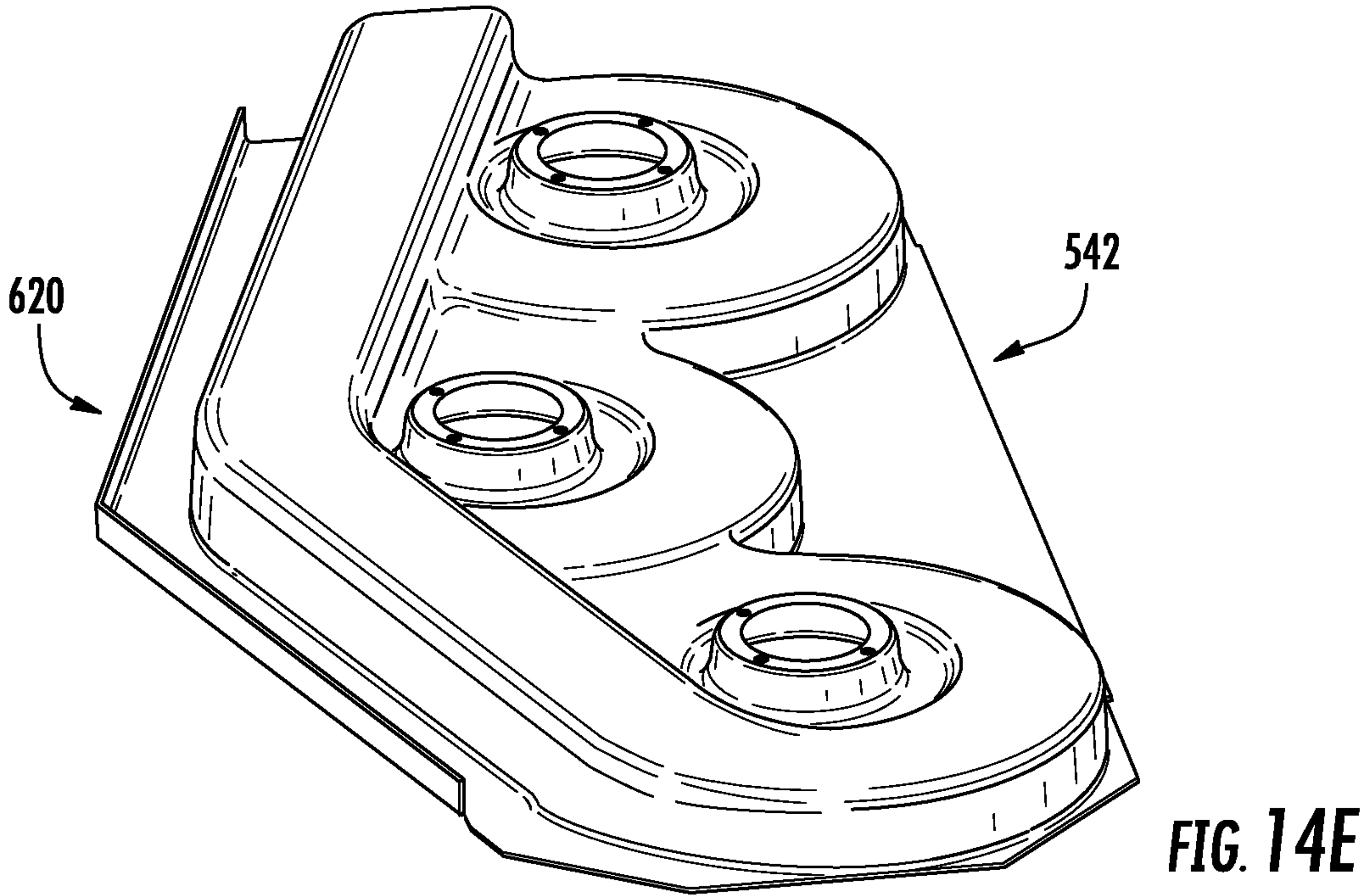
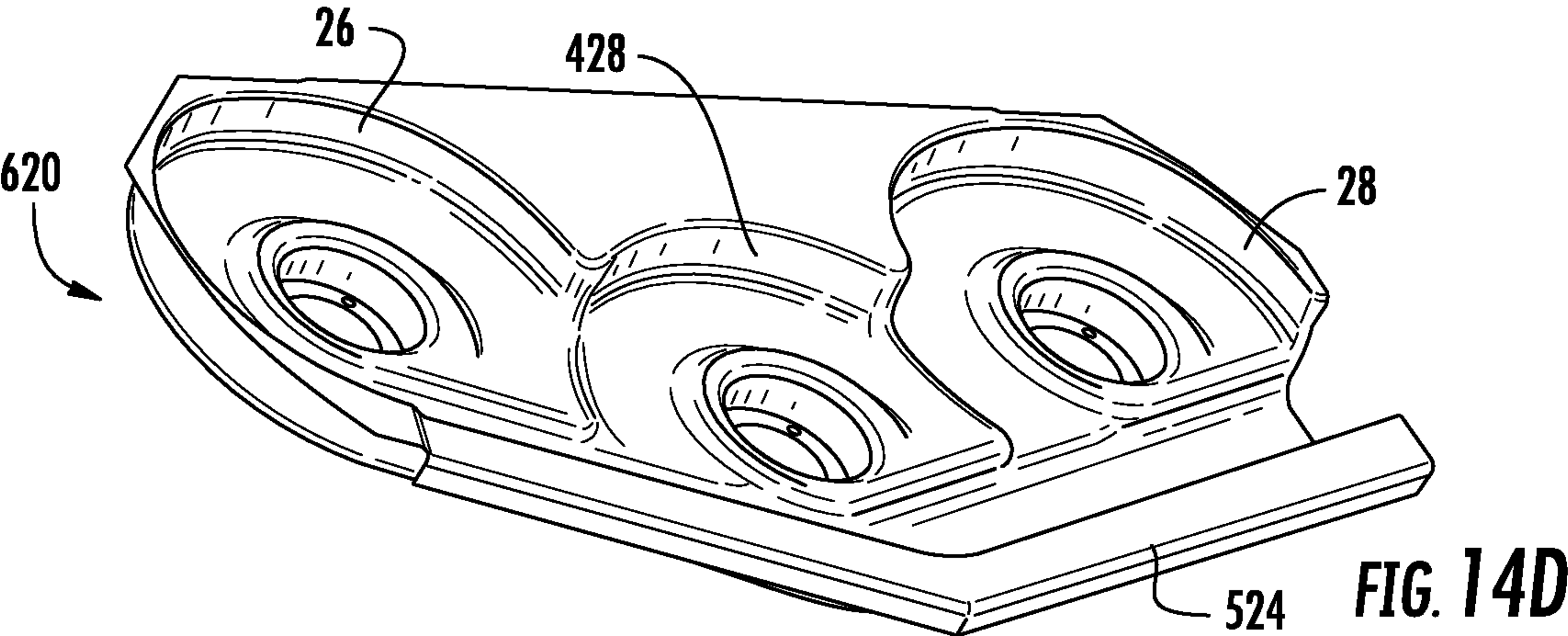


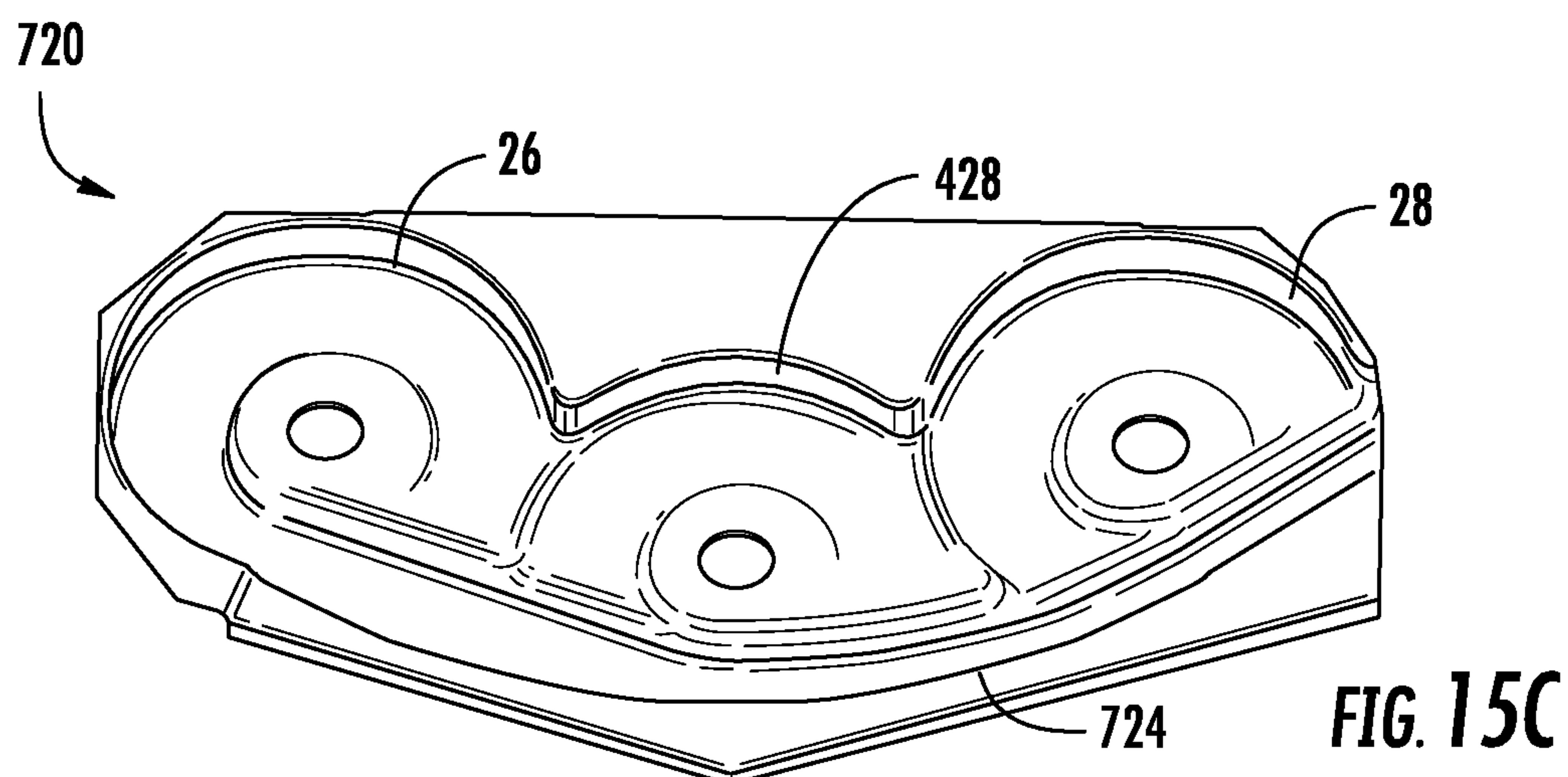
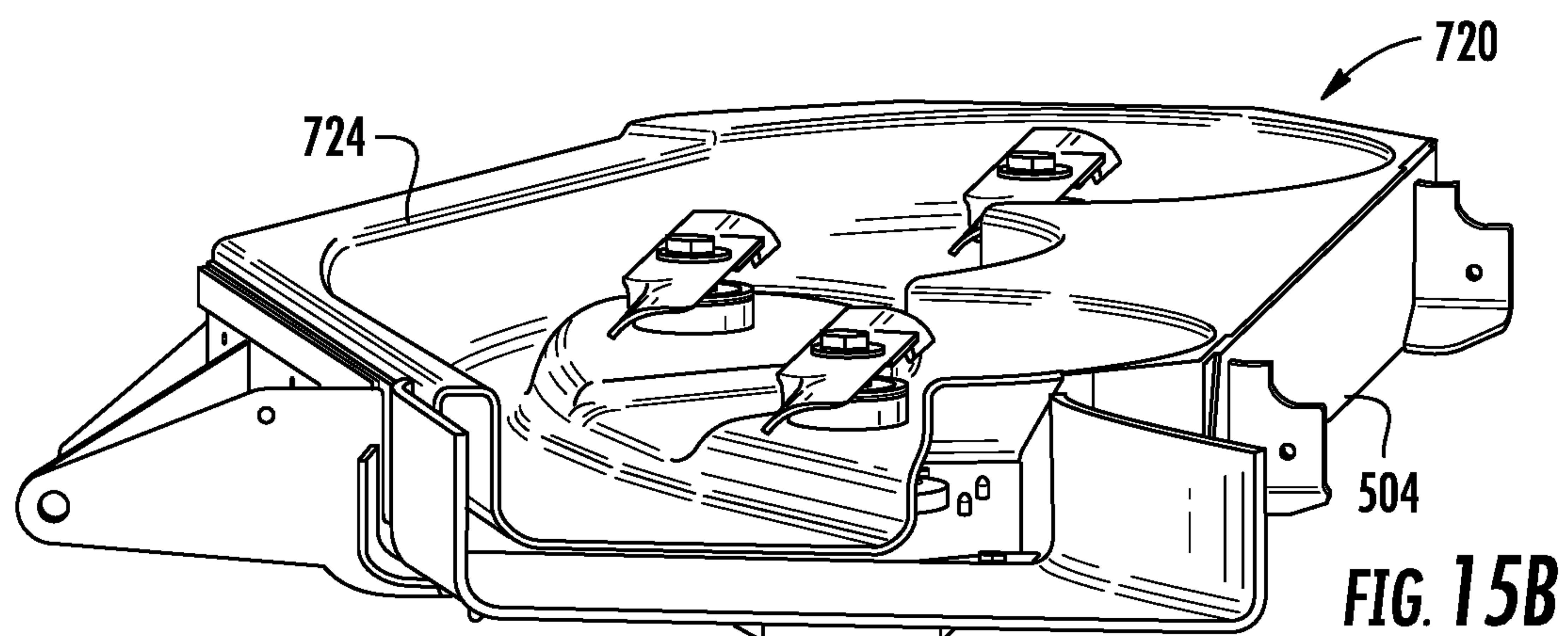
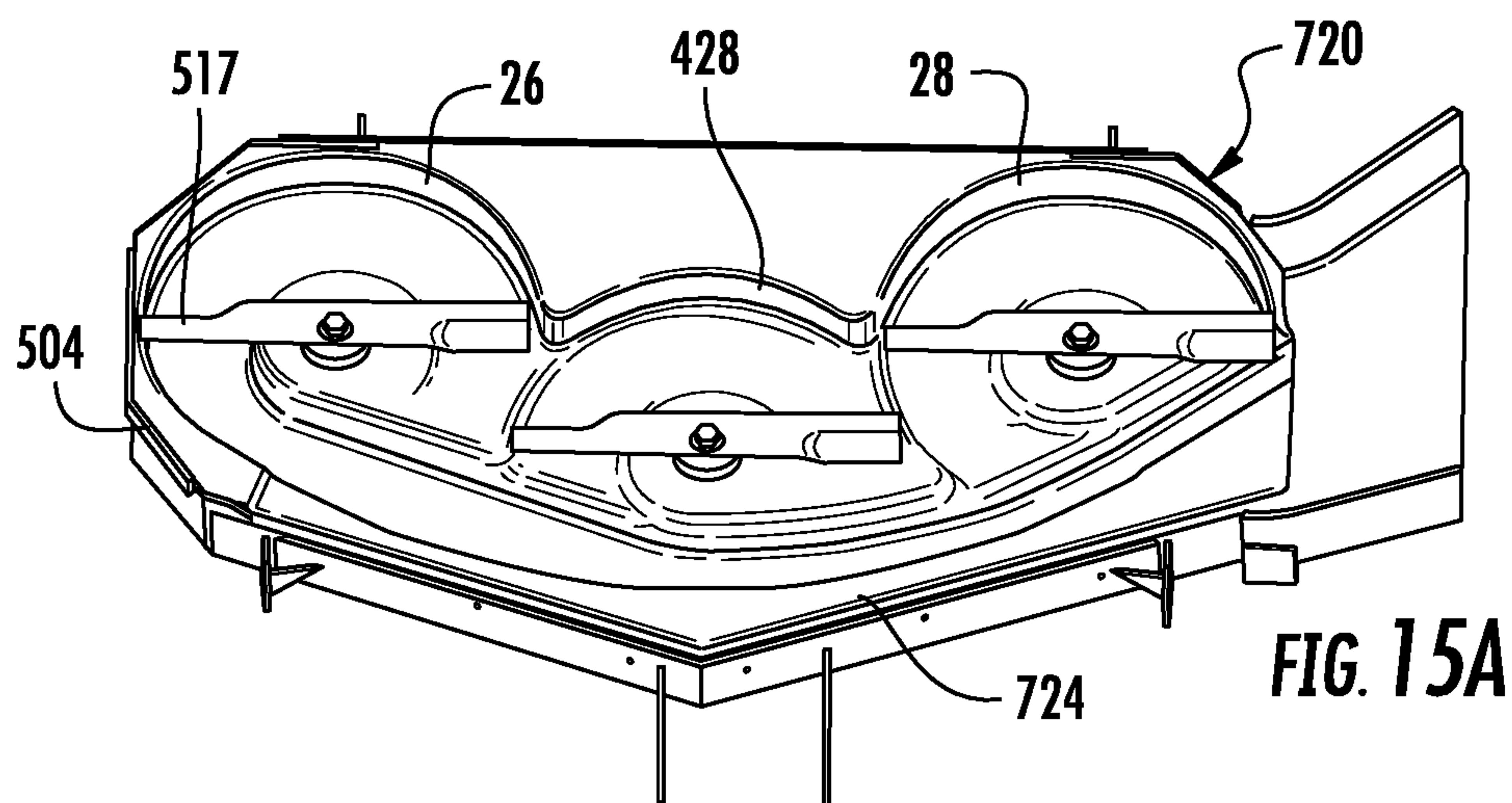


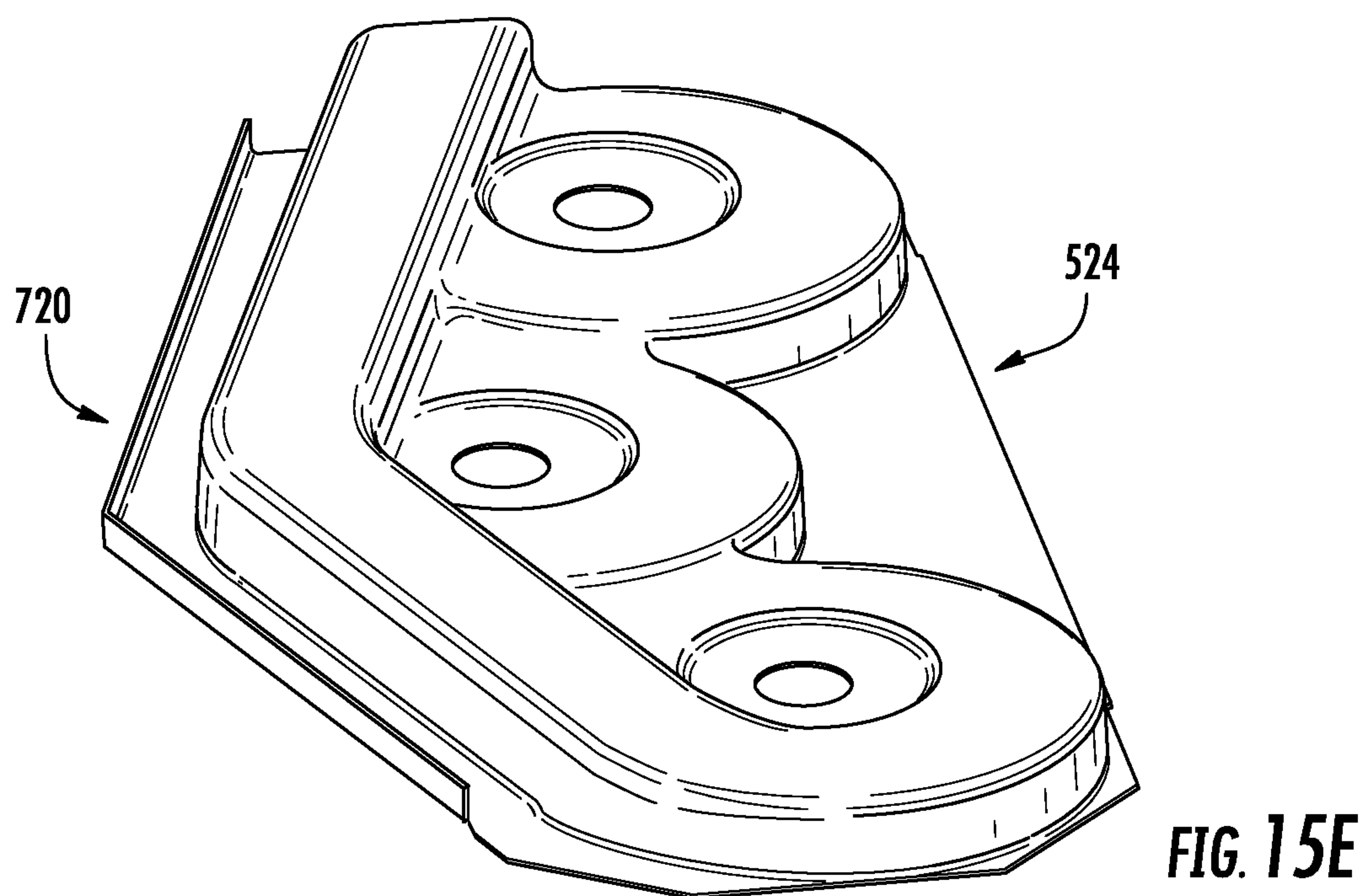
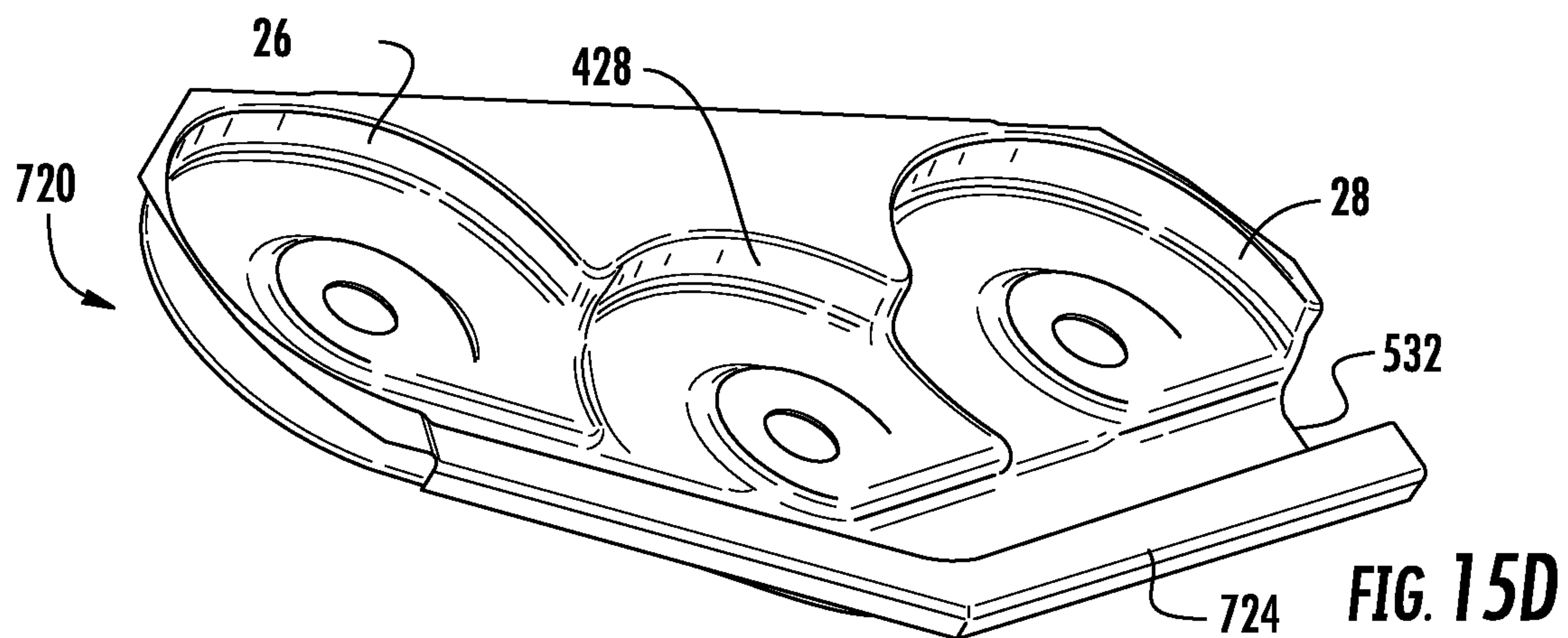




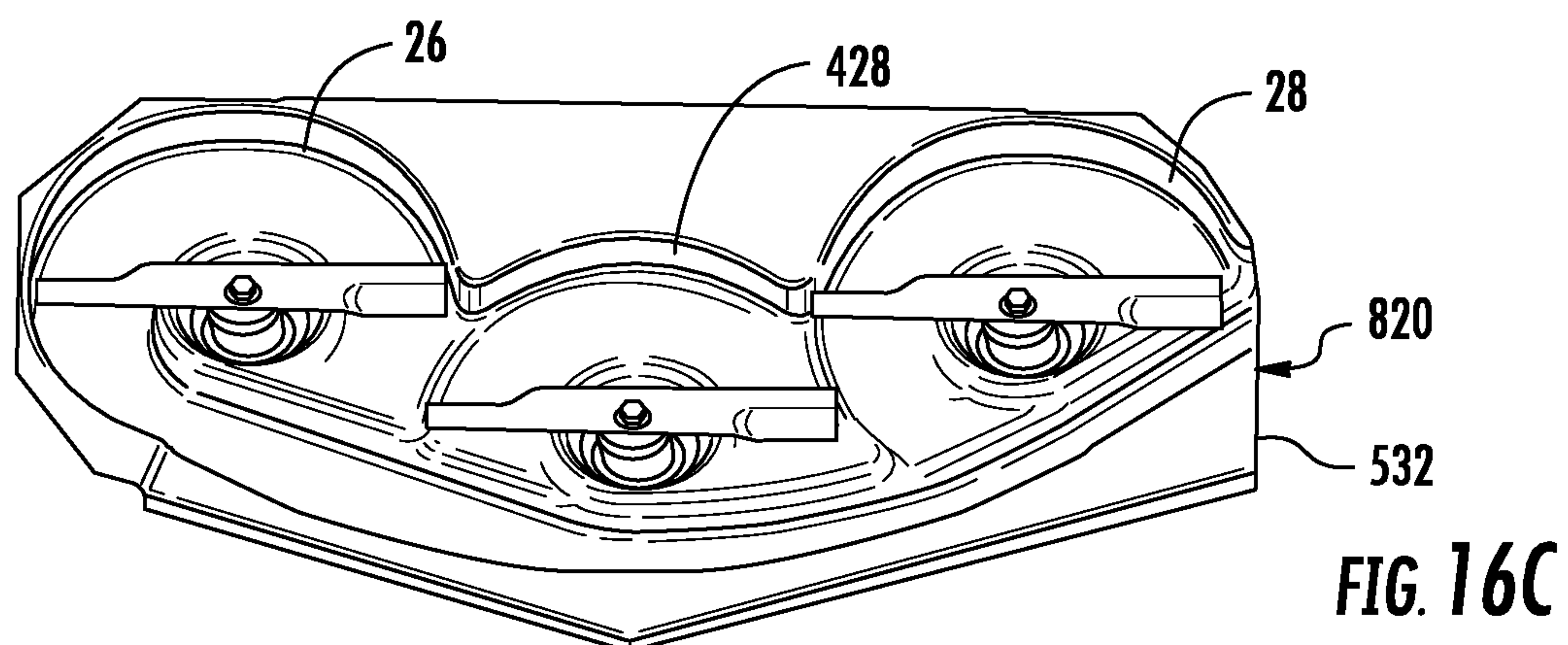
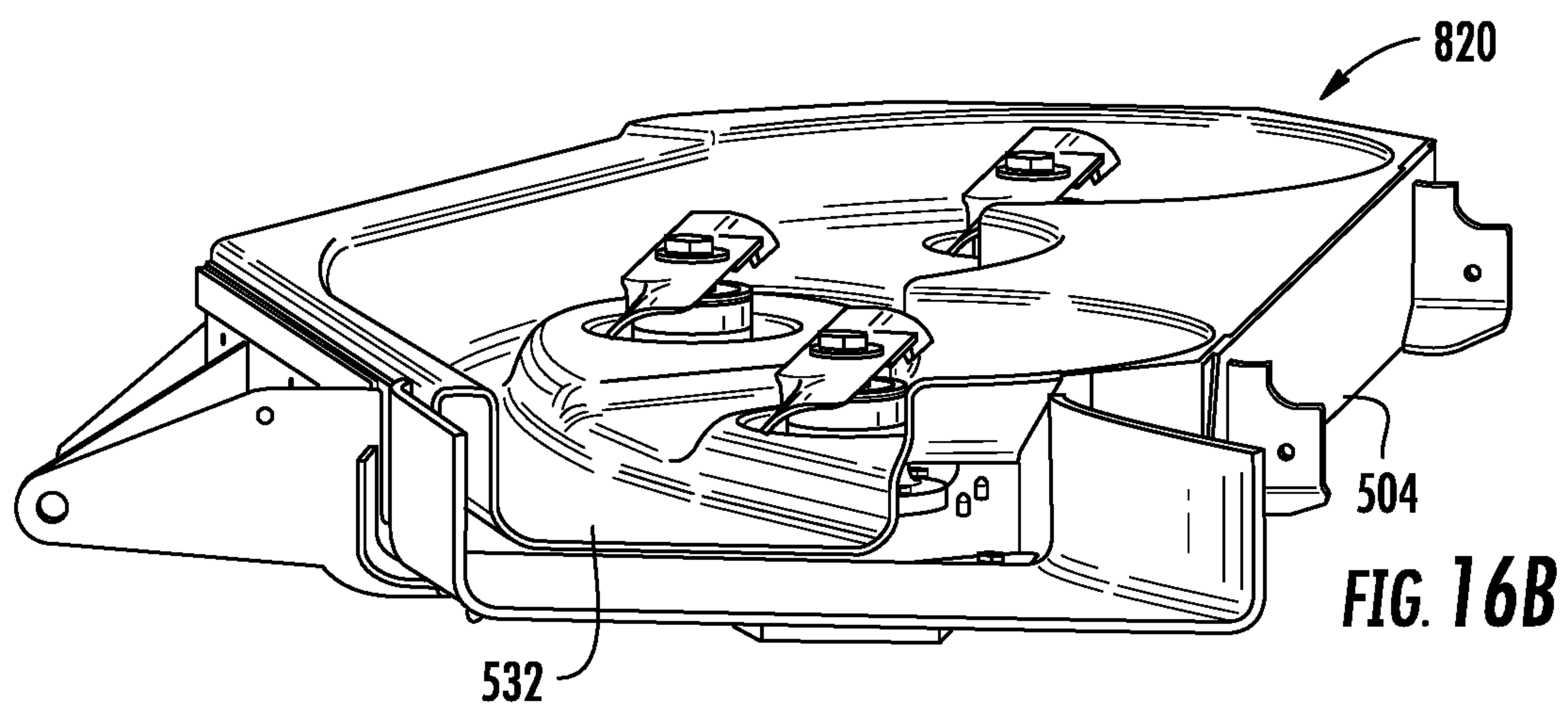
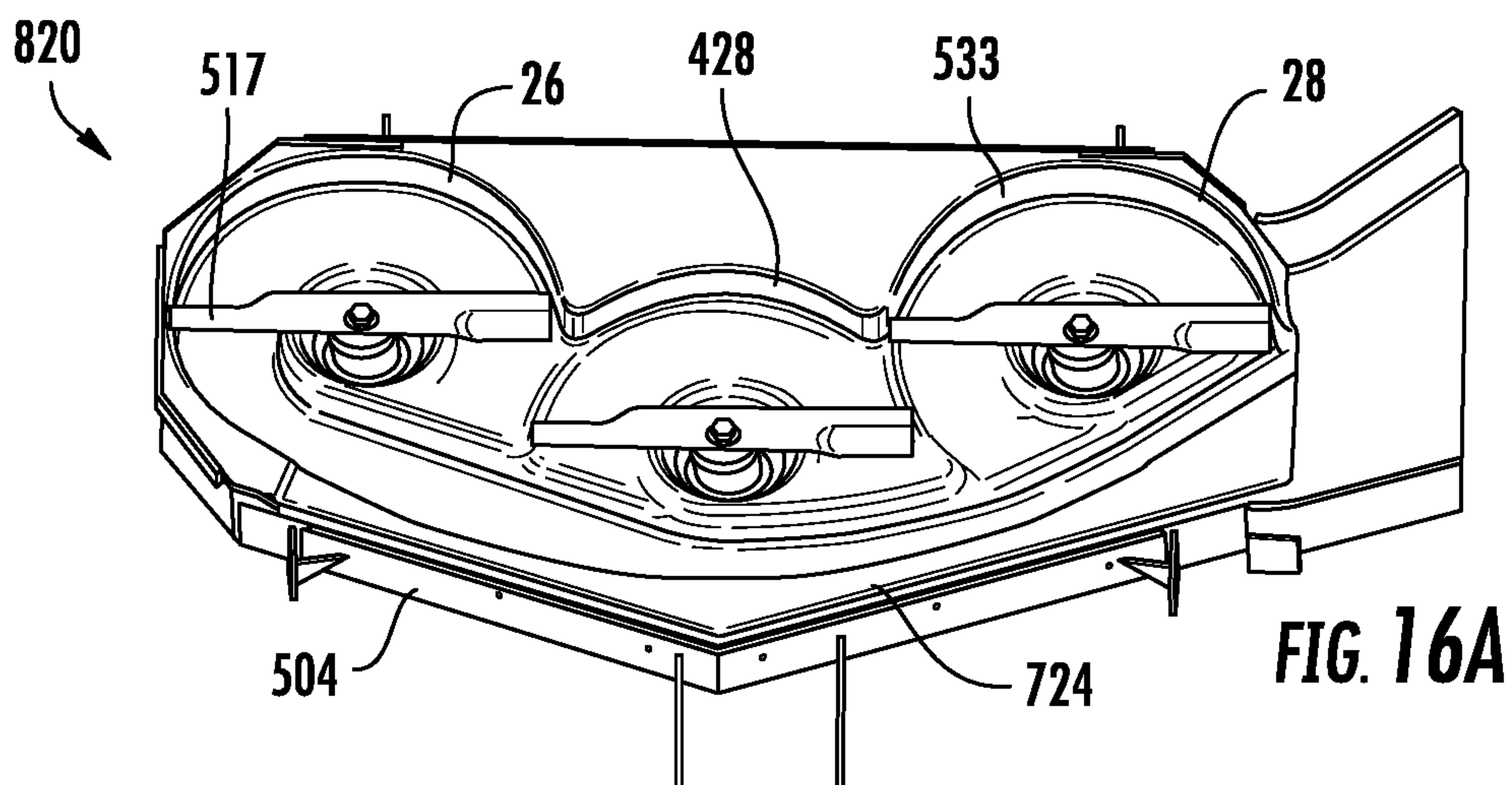












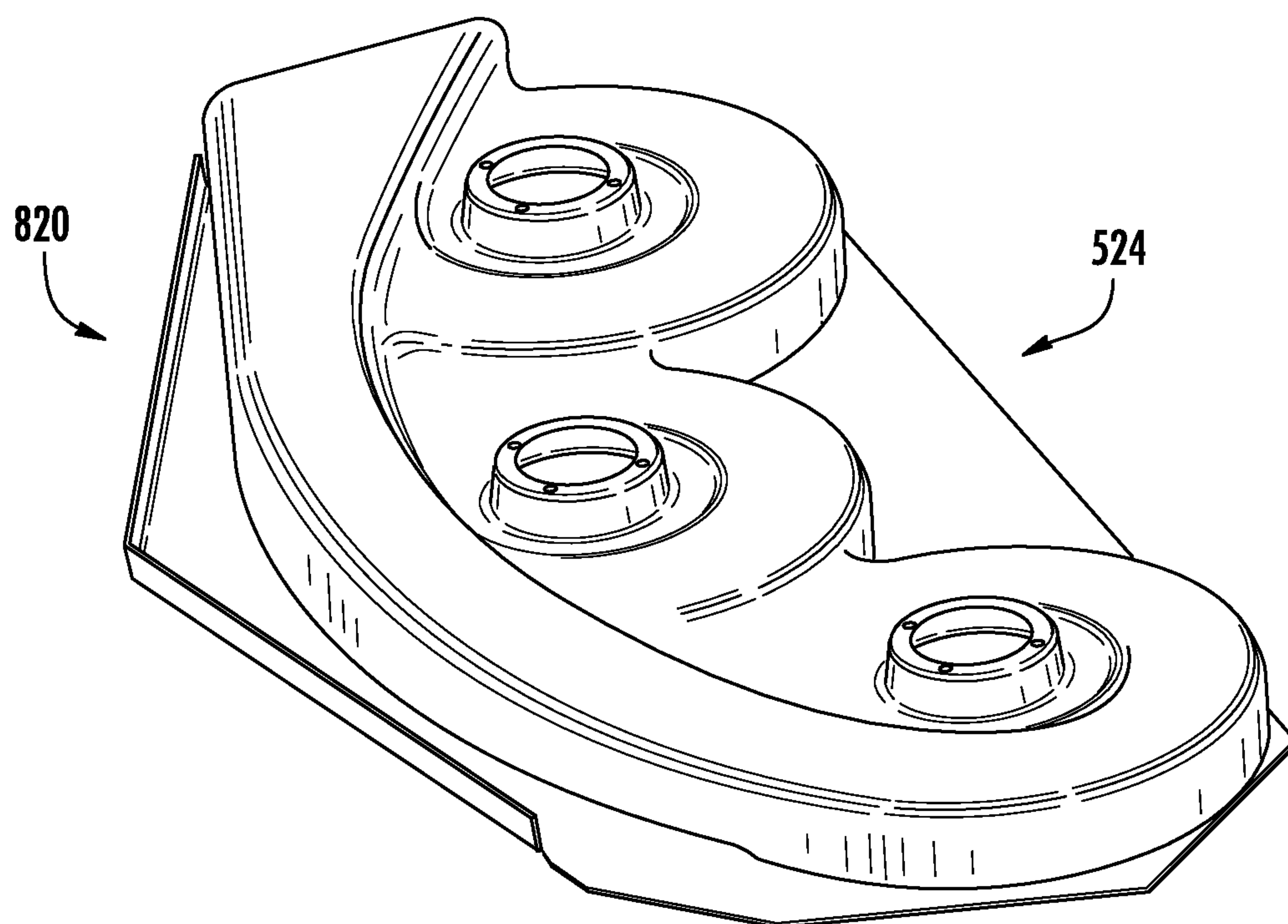
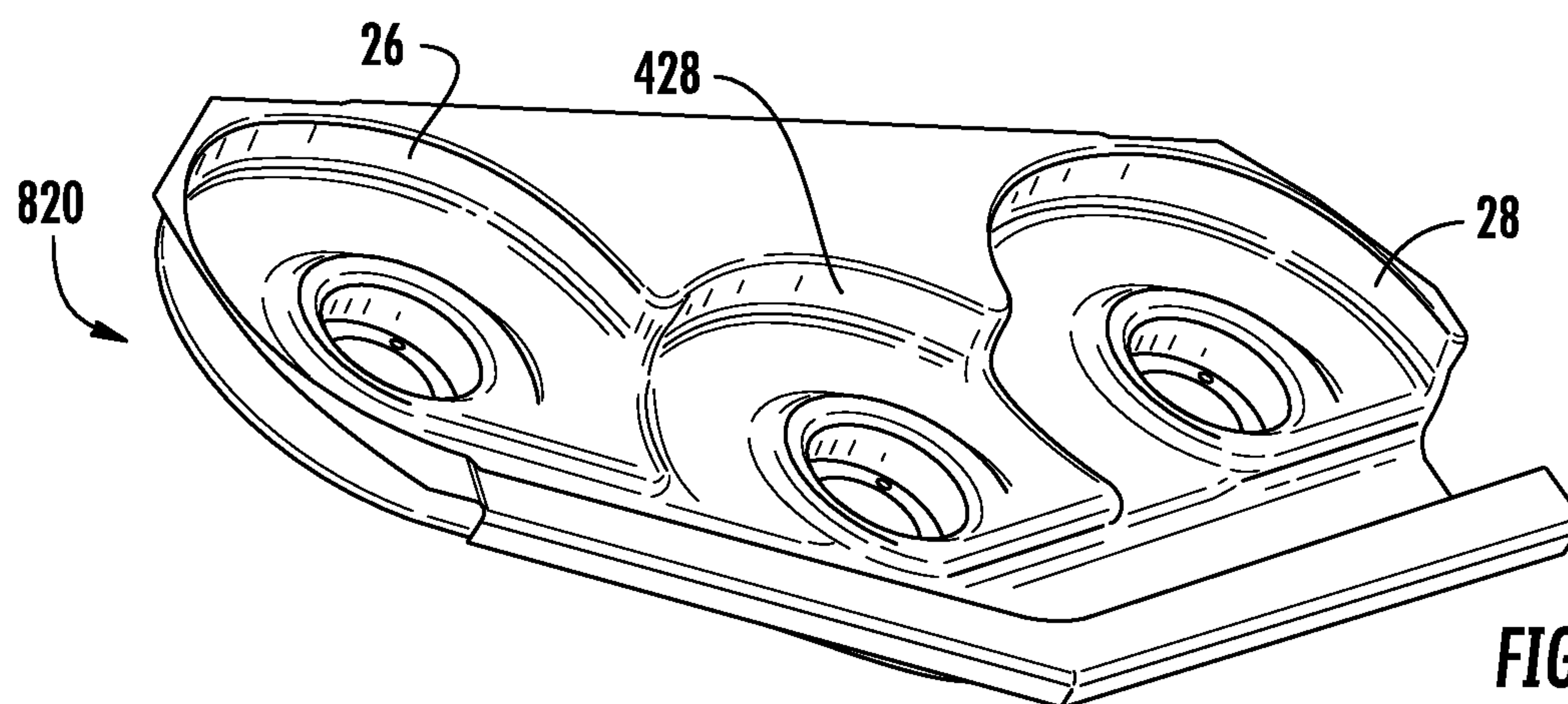
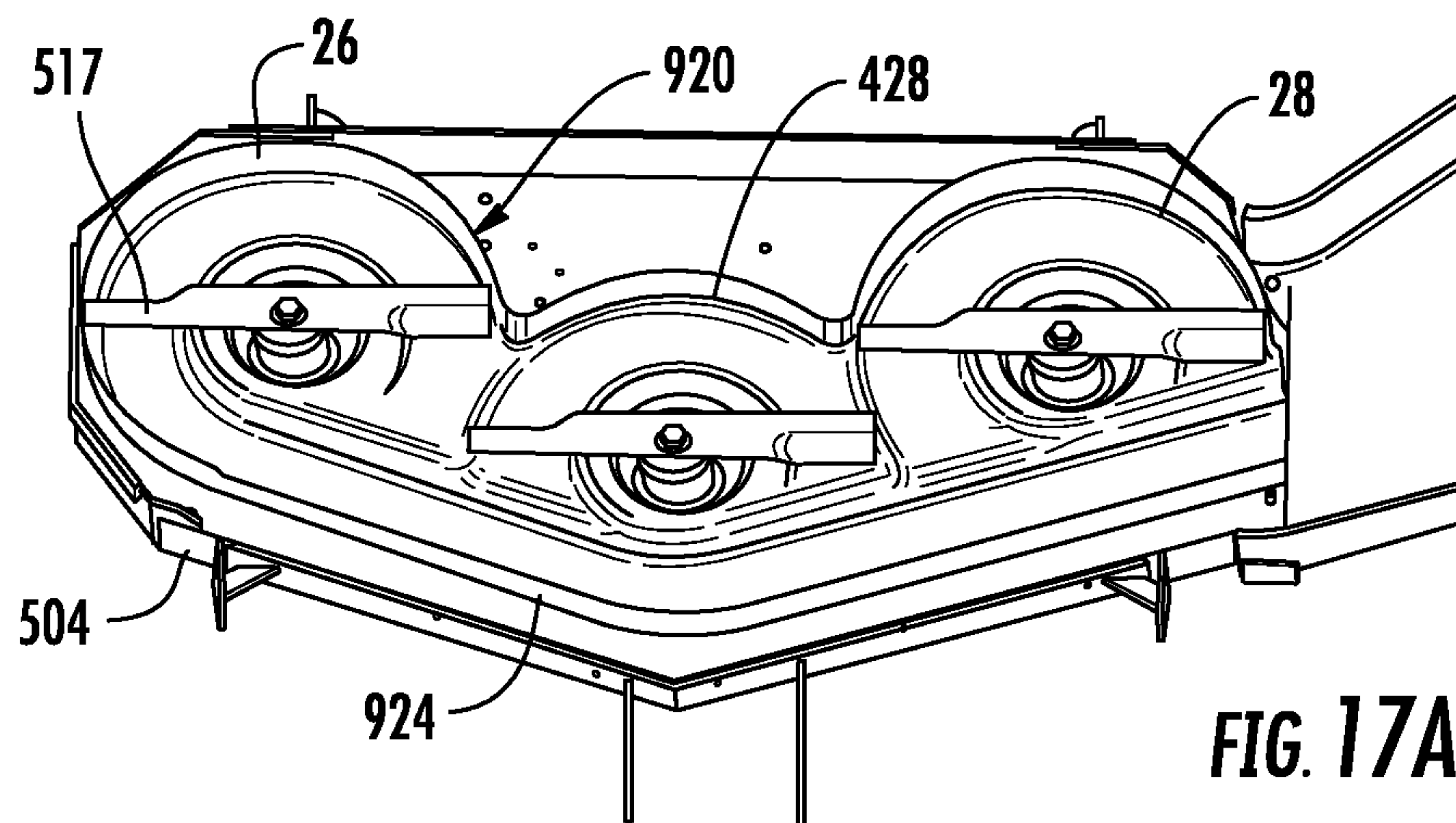
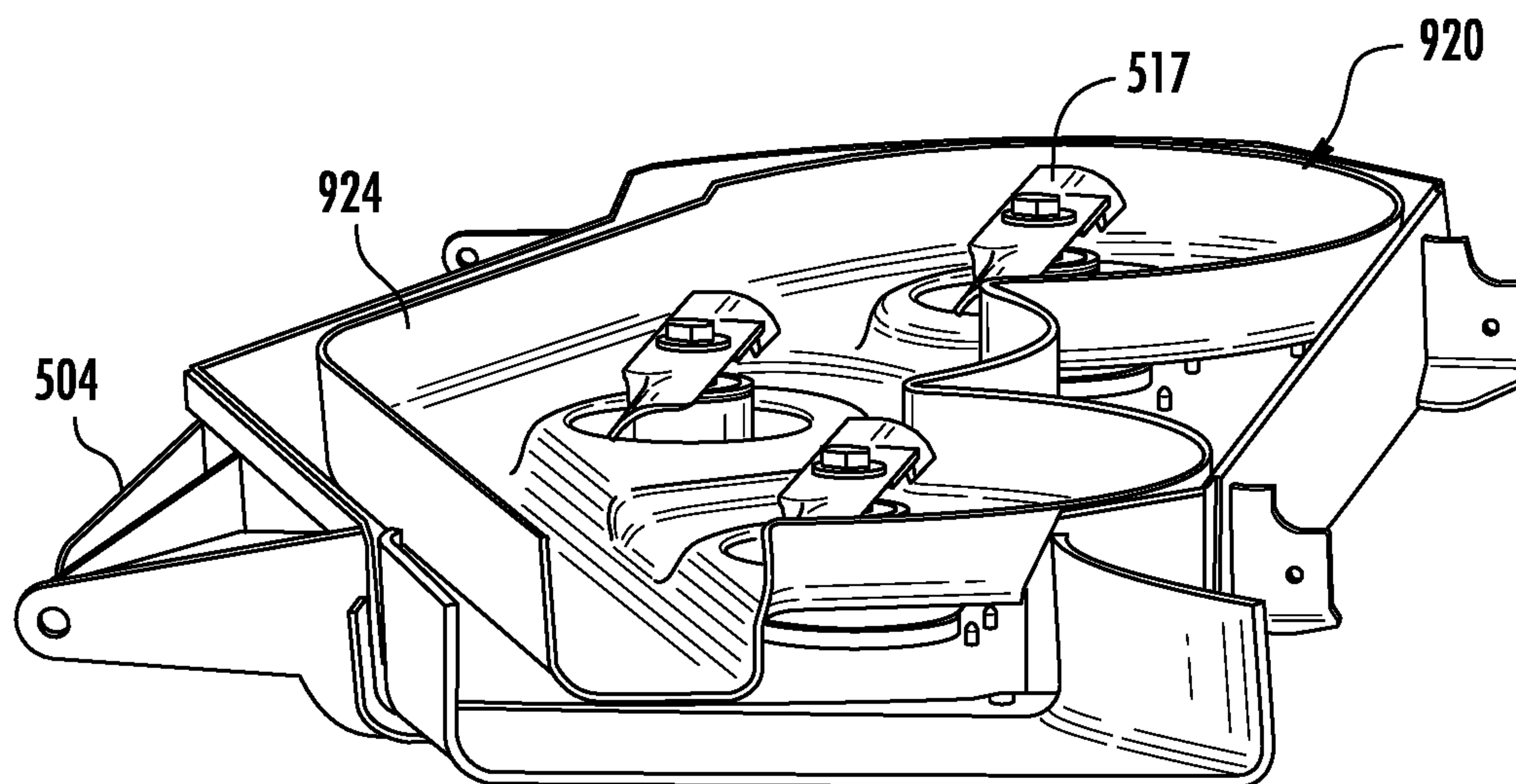


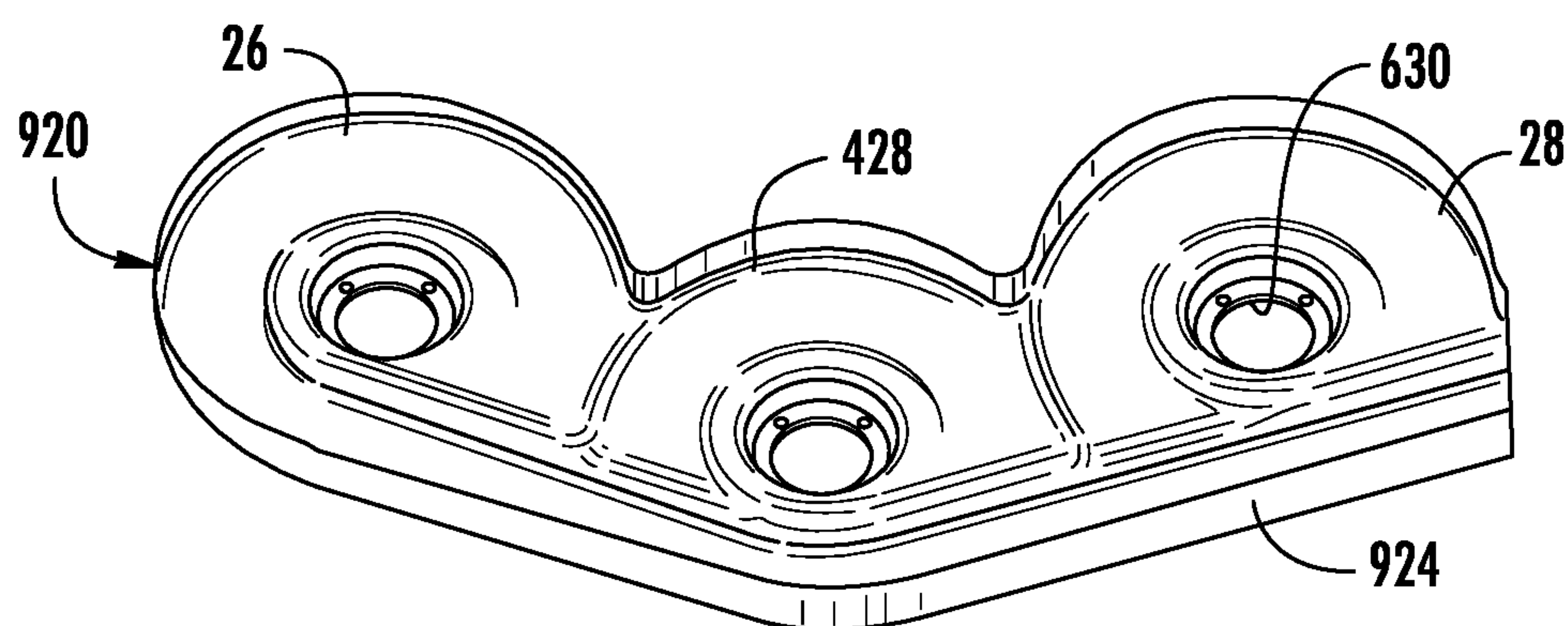
FIG. 16E



**FIG. 17A**

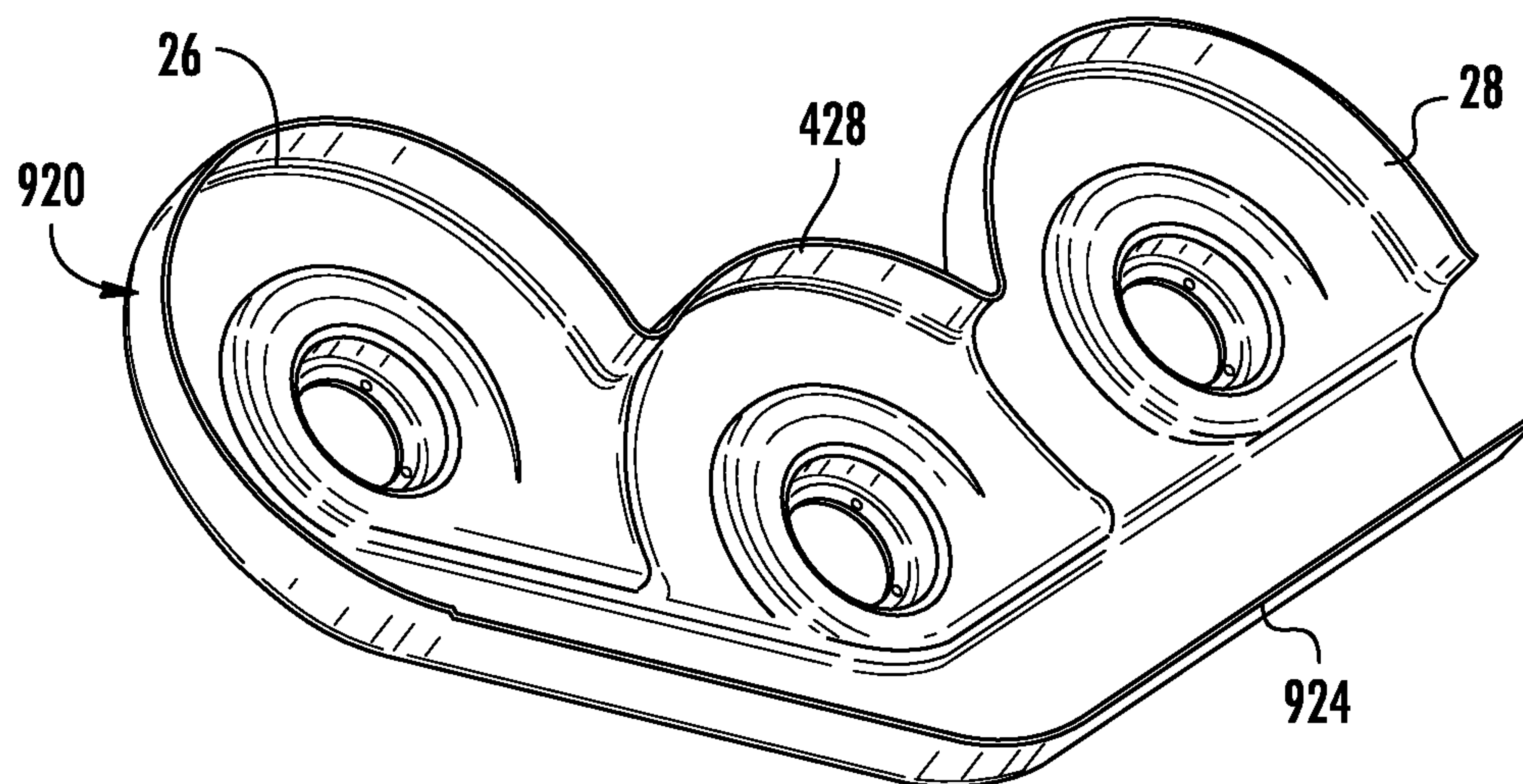


**FIG. 17B**

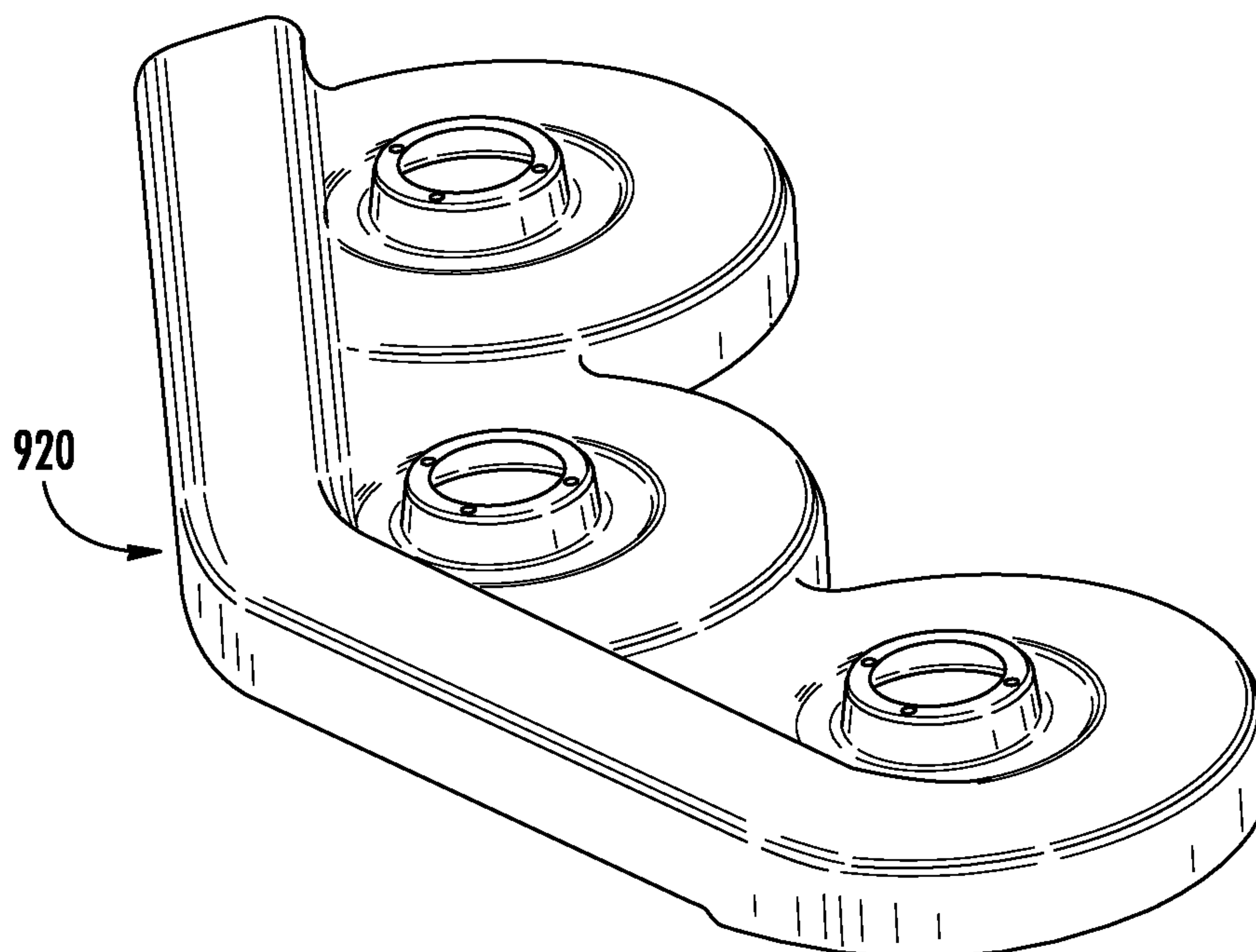


**FIG. 17C**

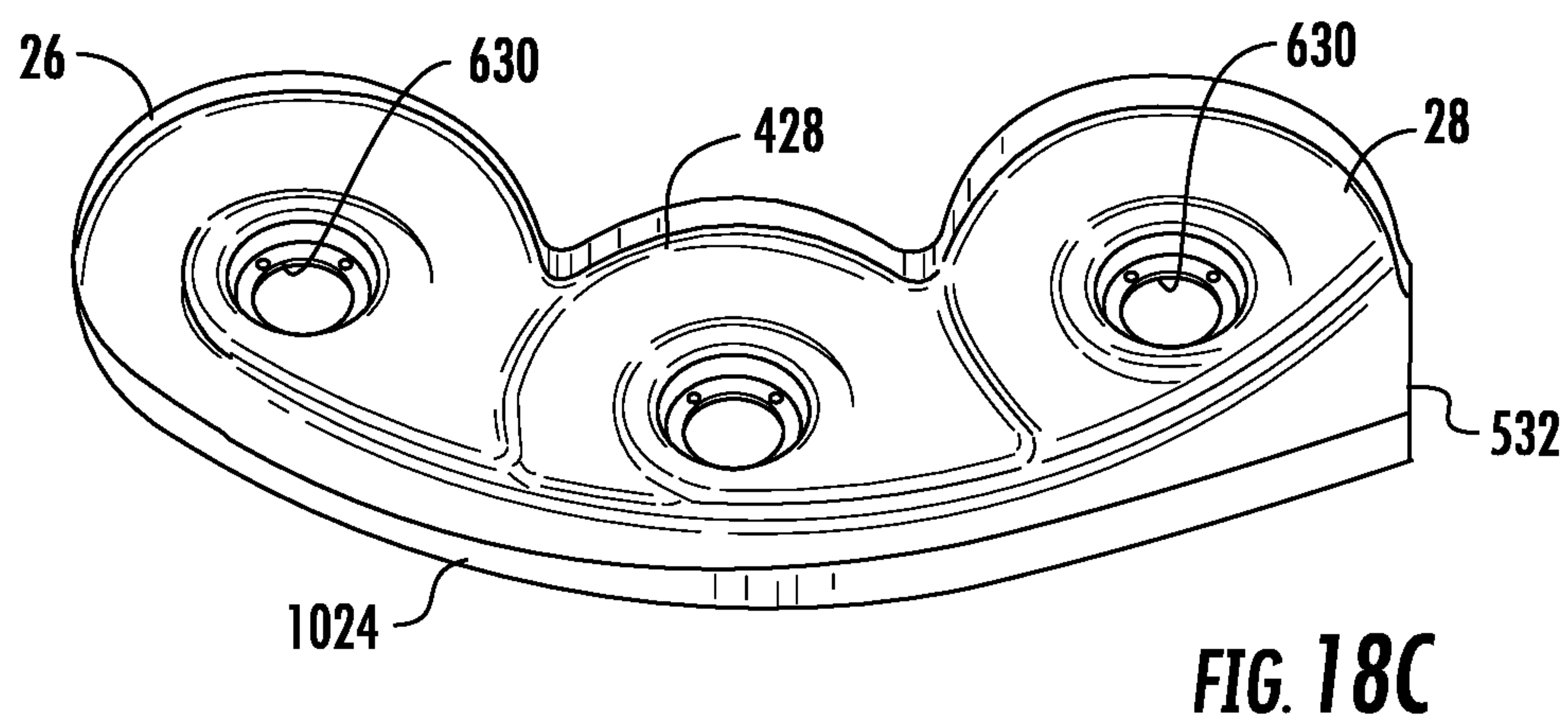
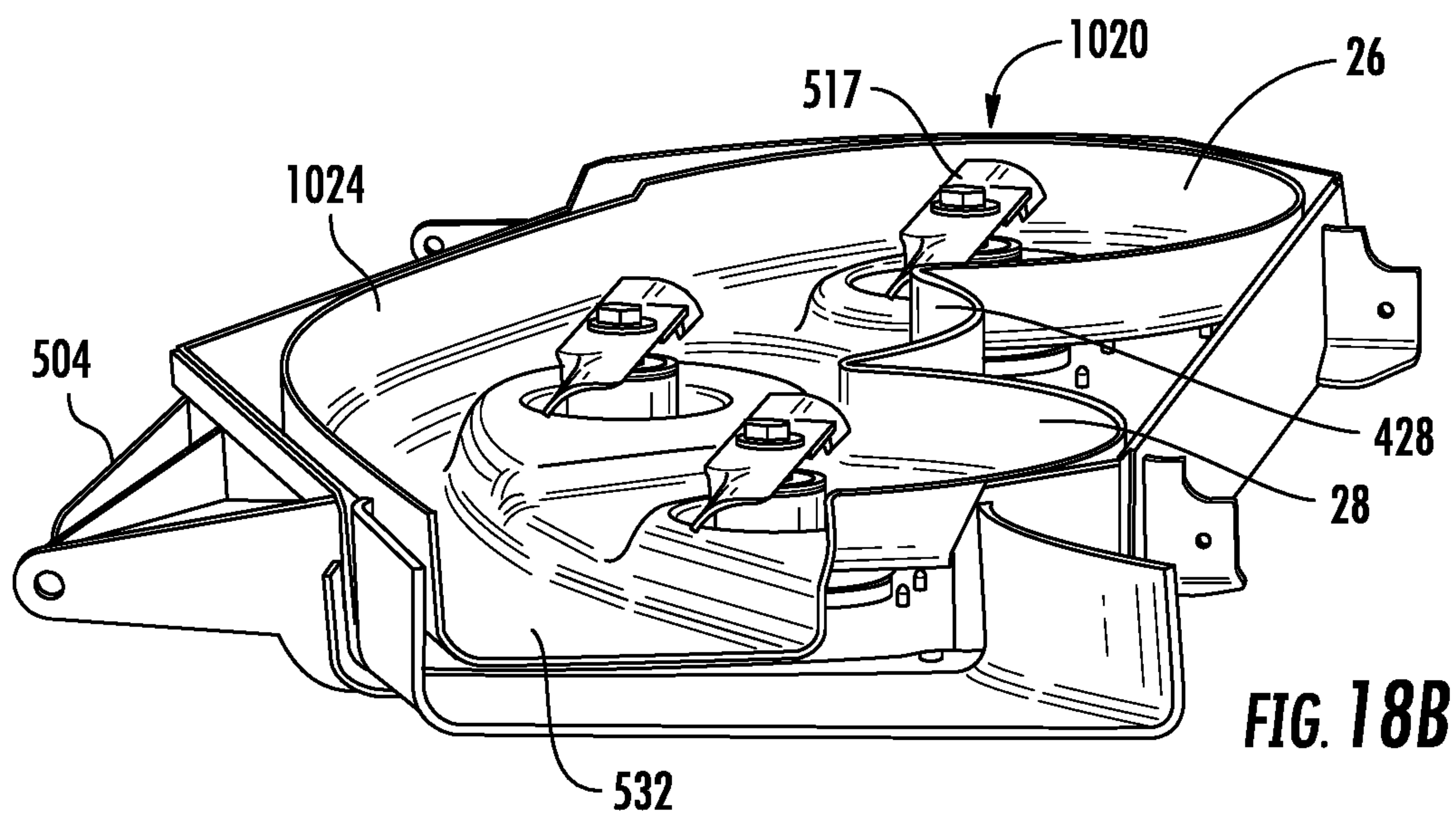
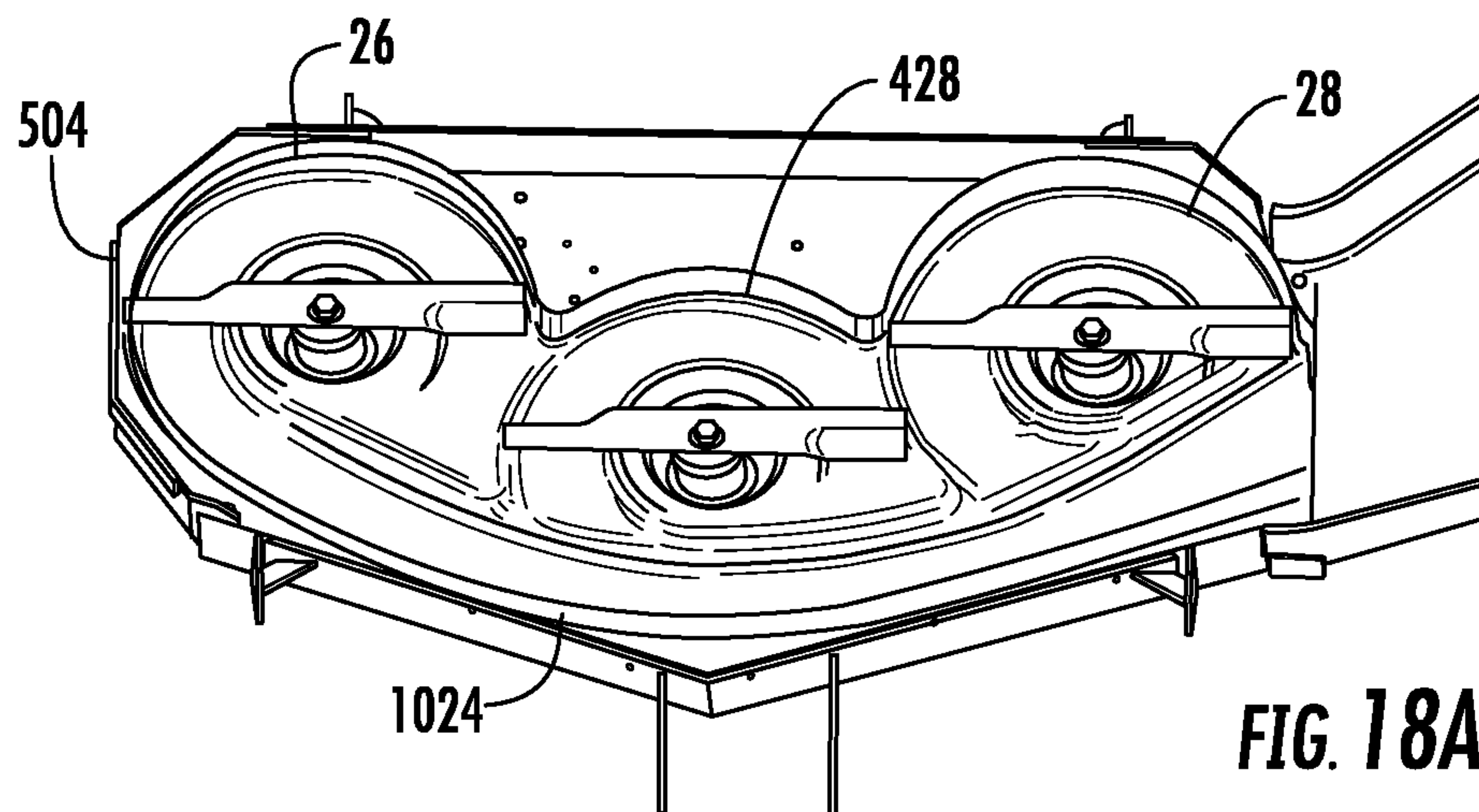


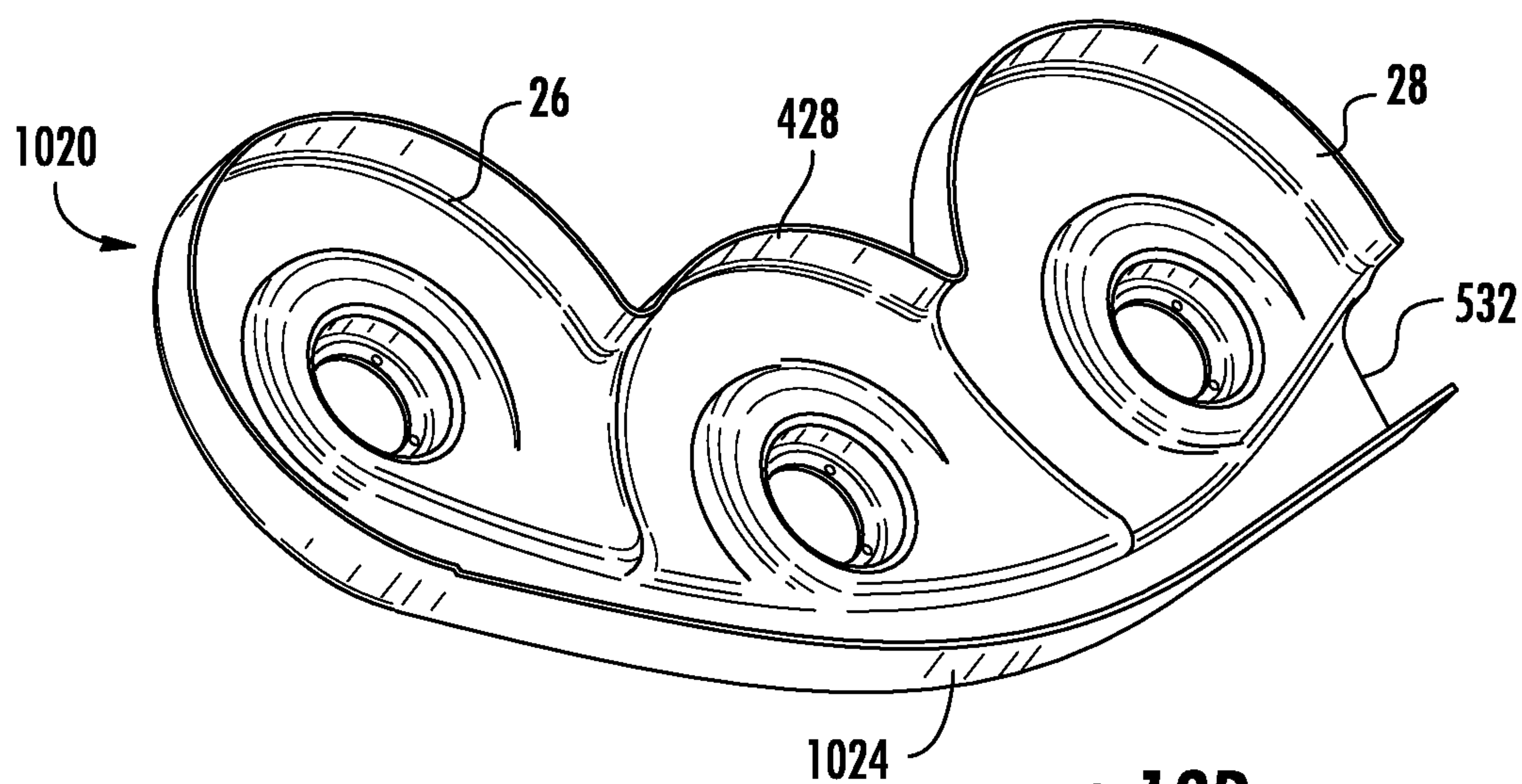


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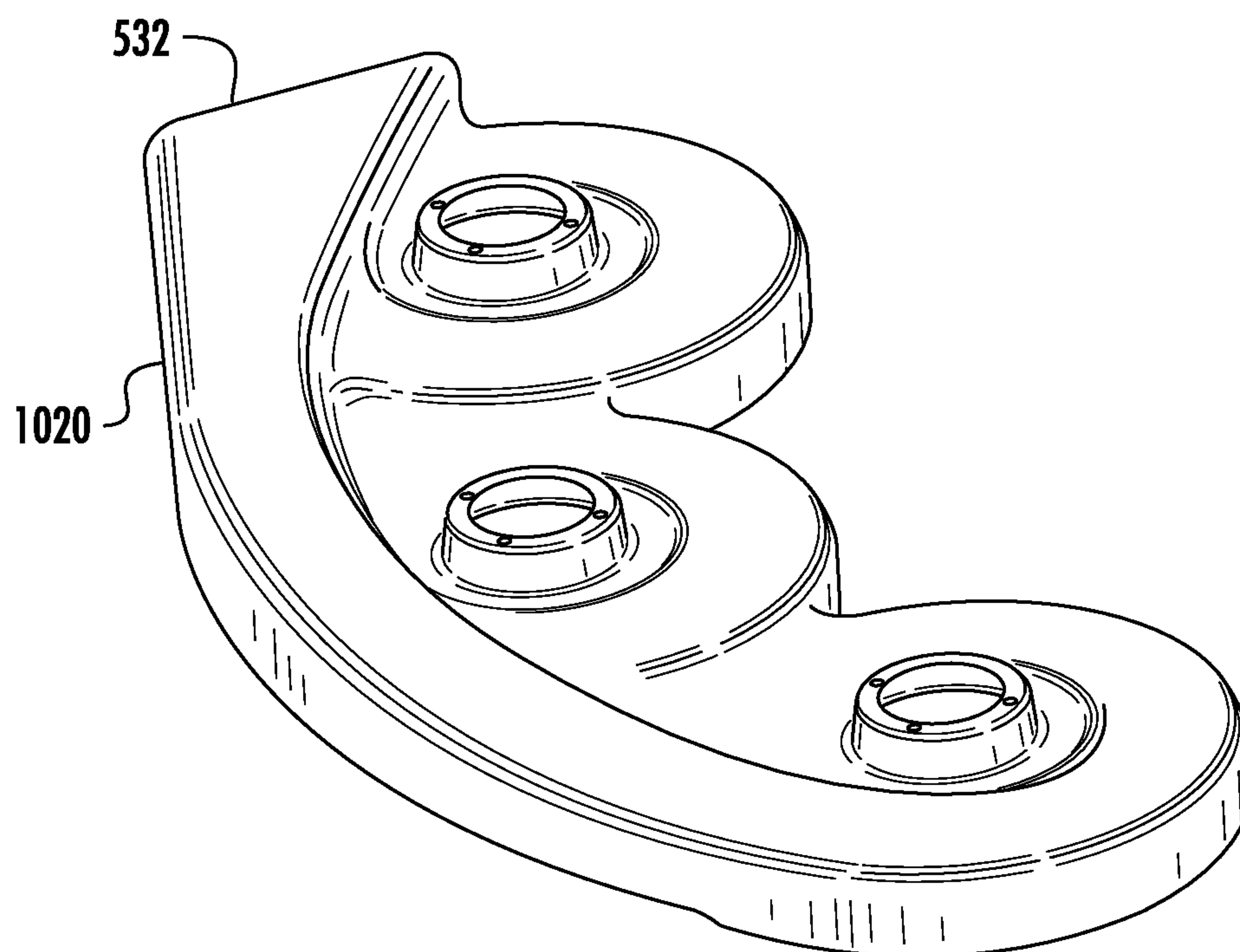


**FIG. 17E**





**FIG. 18D**



**FIG. 18E**



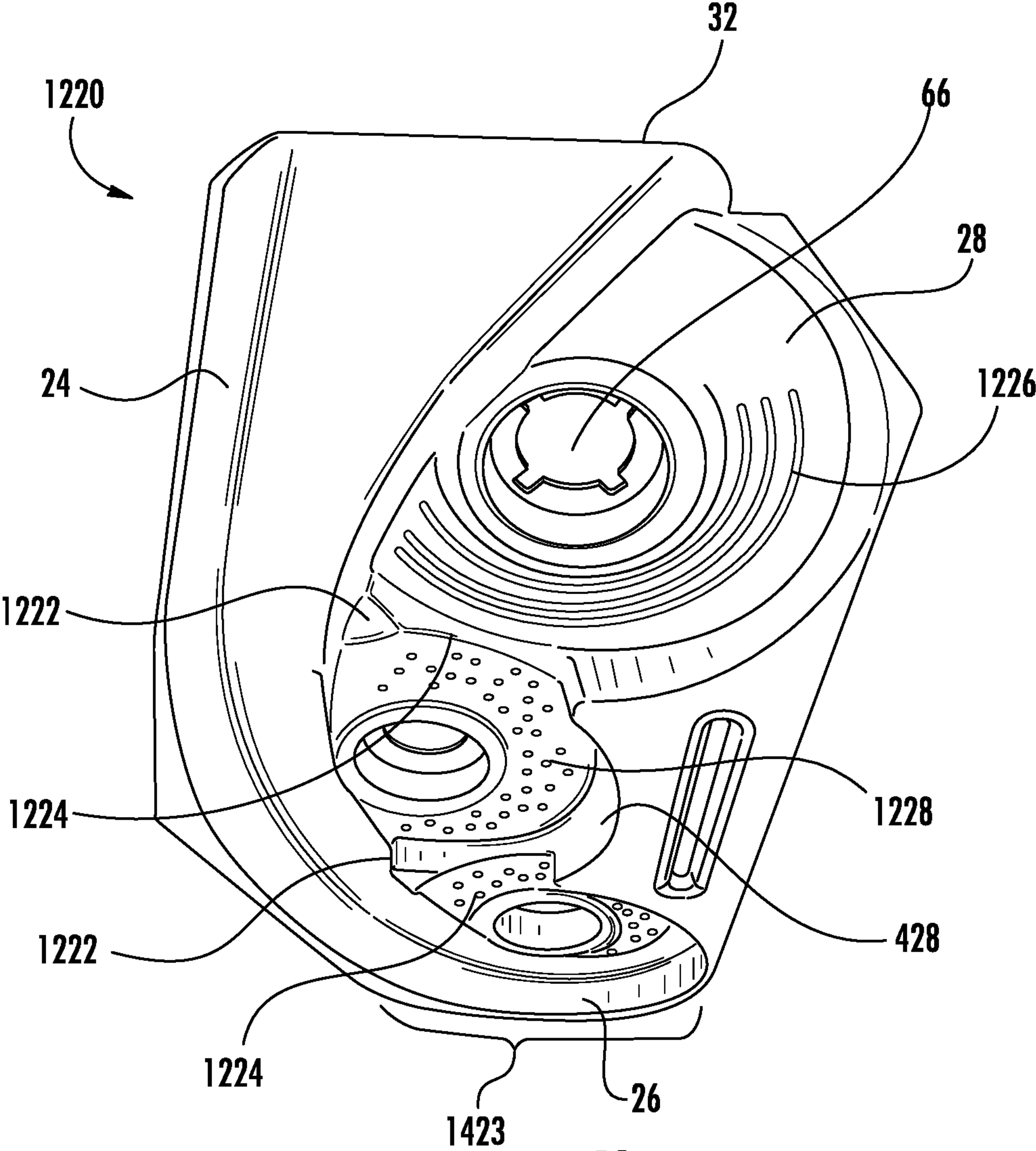


FIG. 19

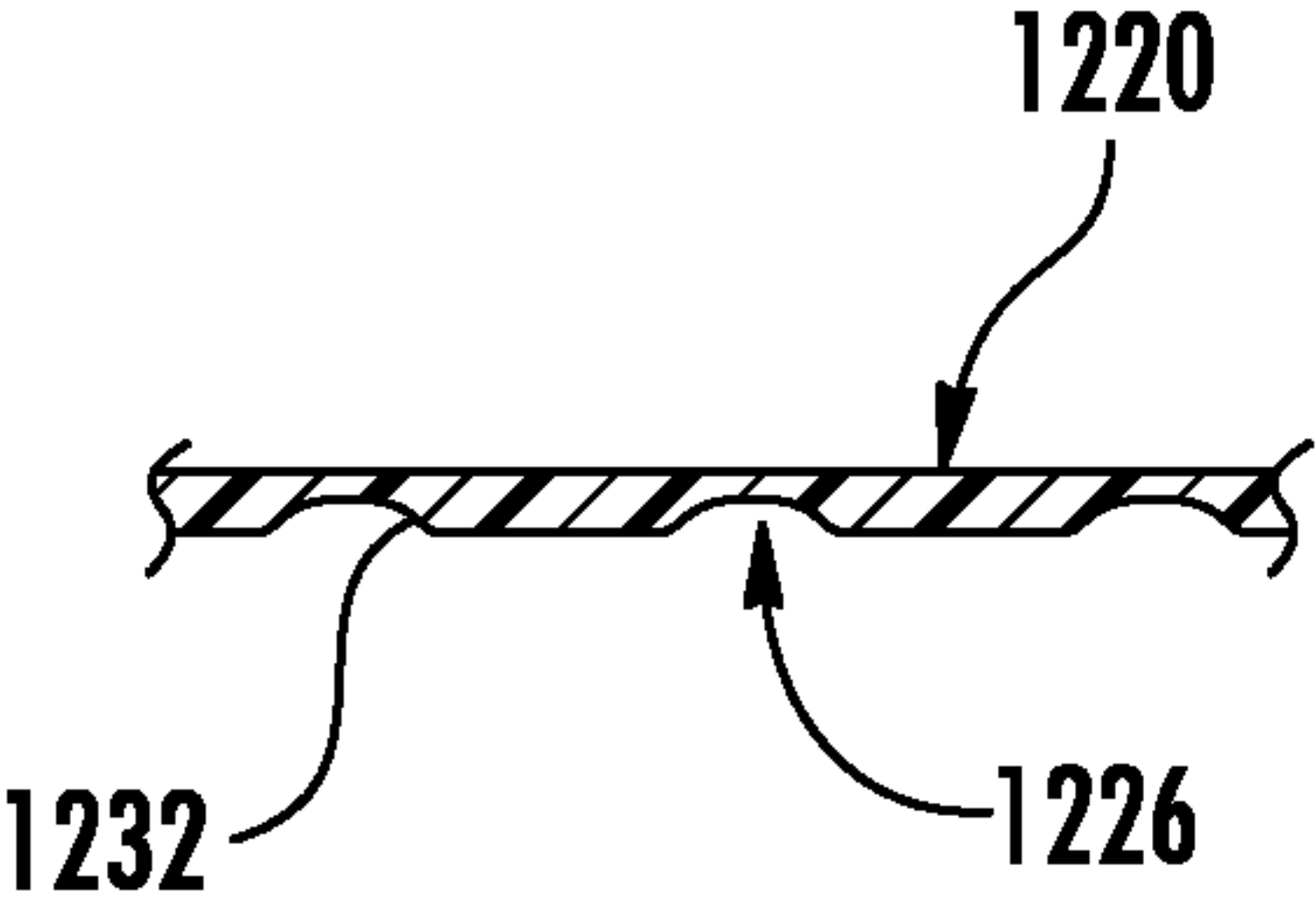


FIG. 20

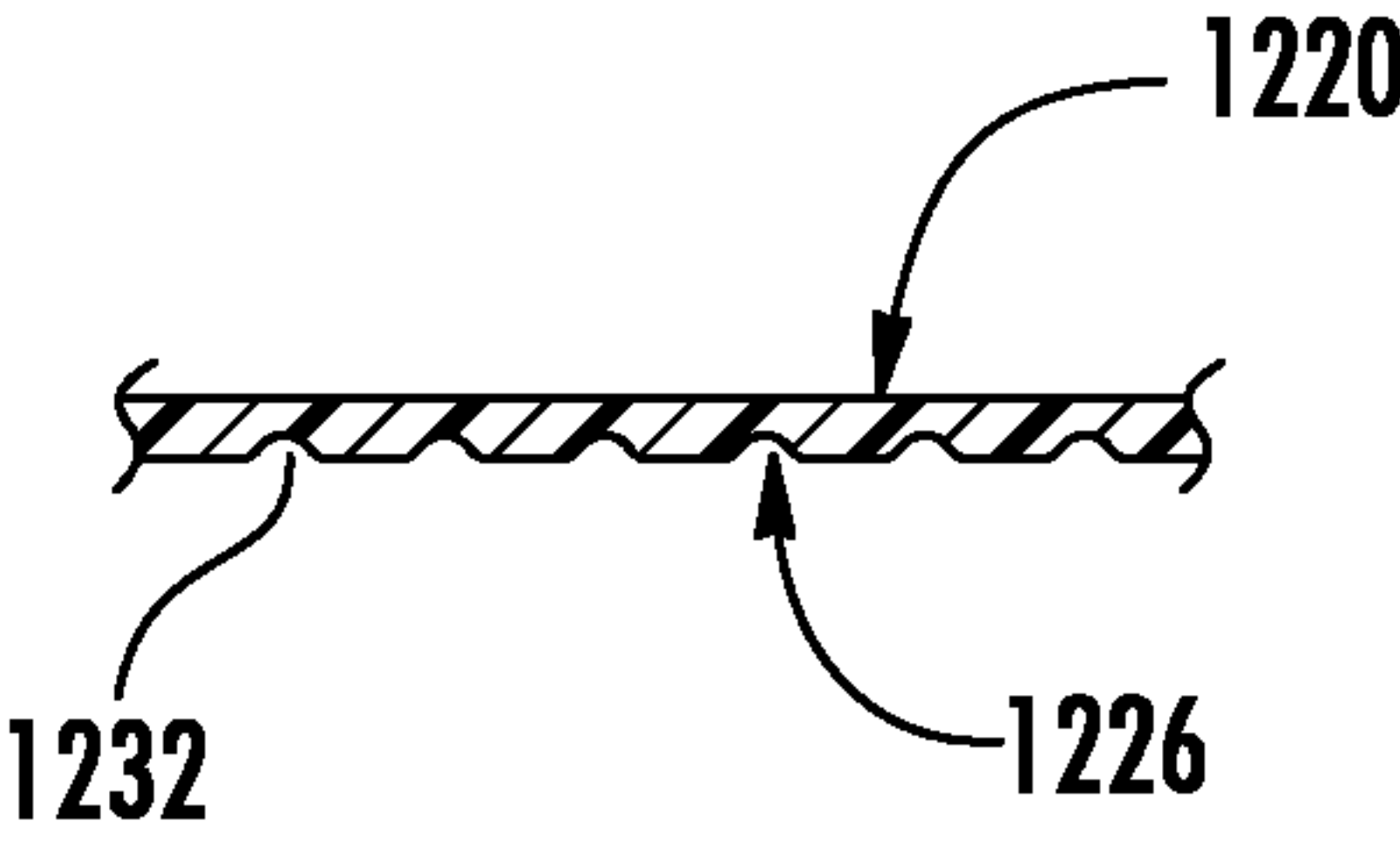


FIG. 21

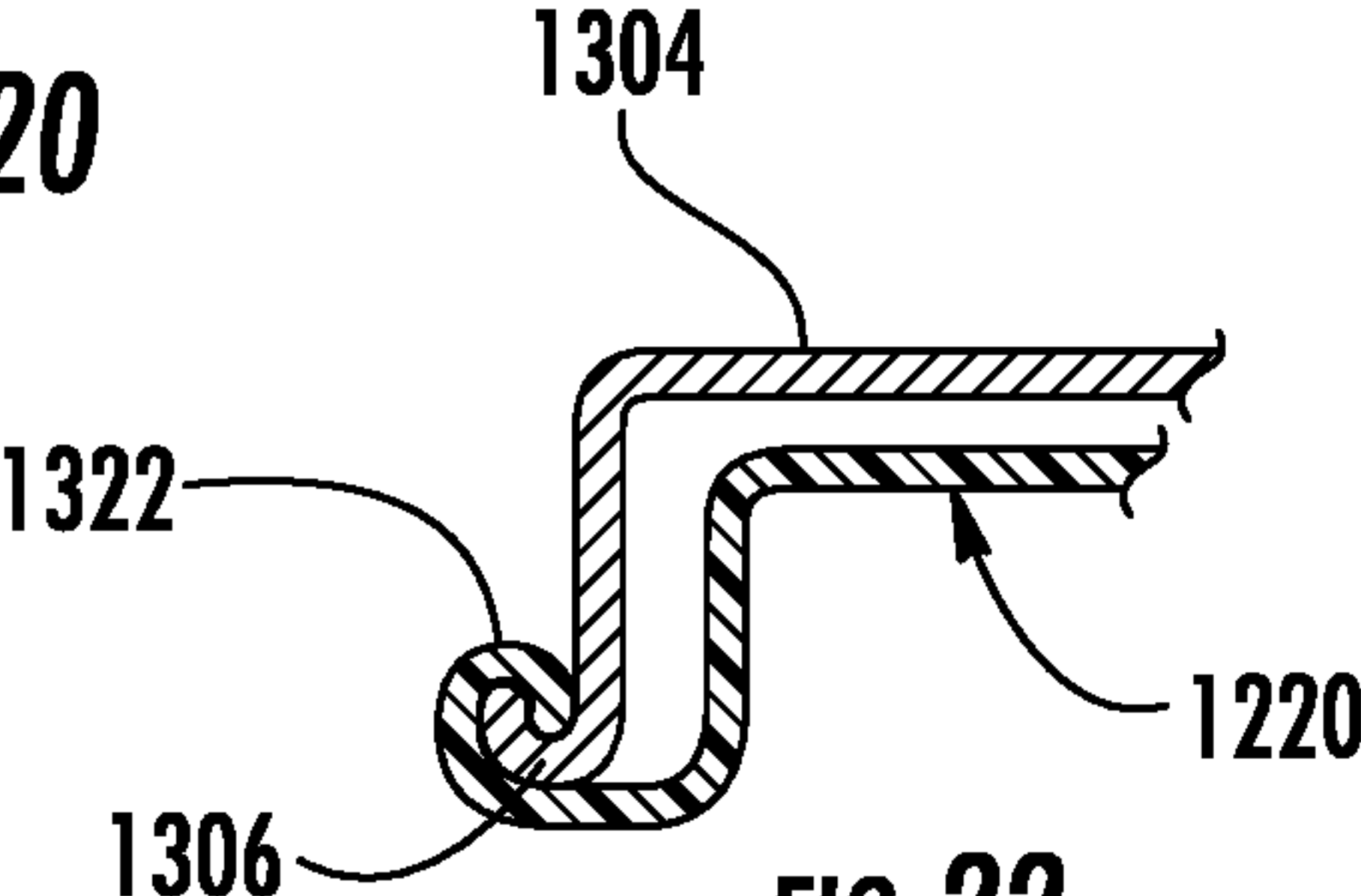


FIG. 22

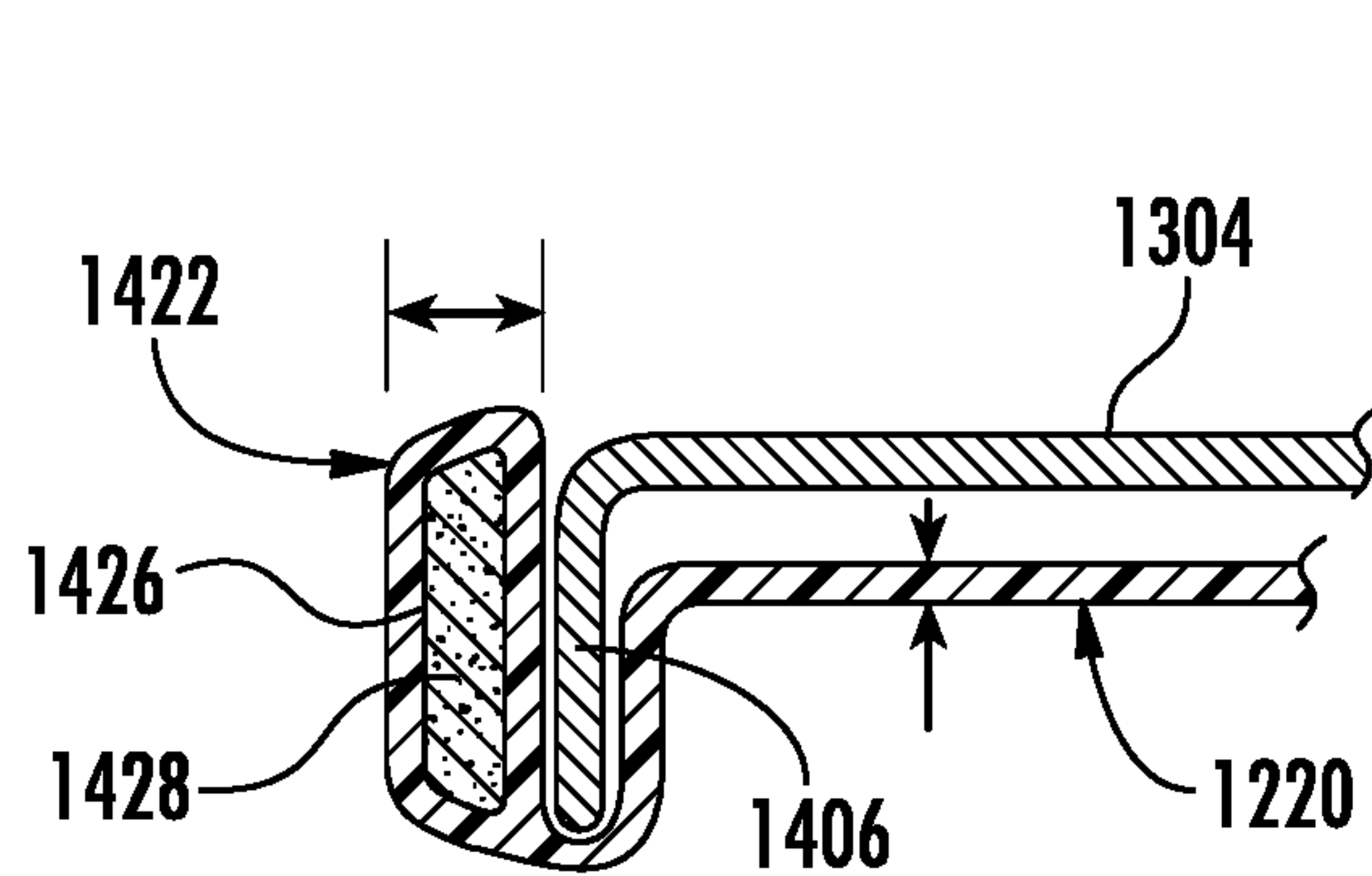


FIG. 23A

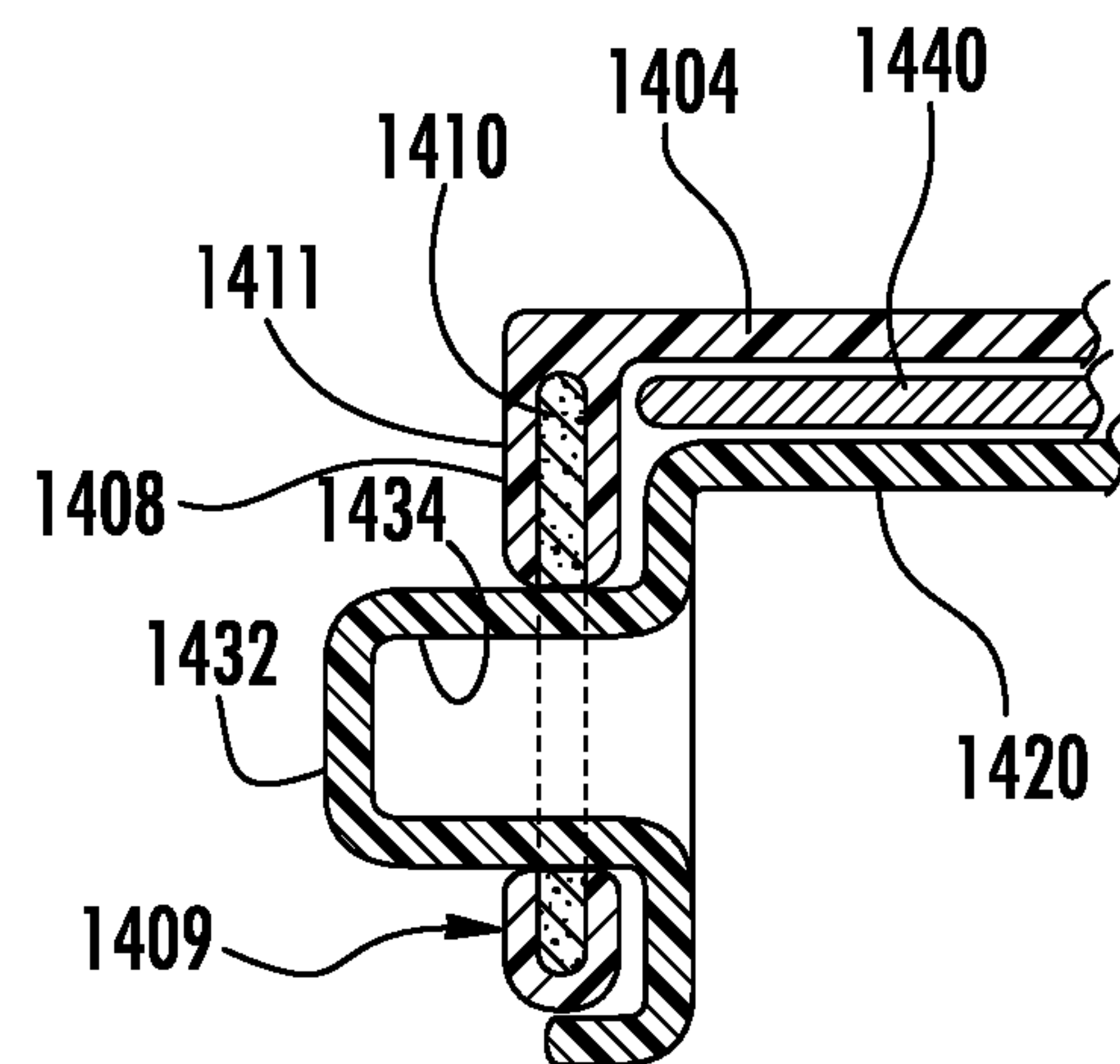


FIG. 23B

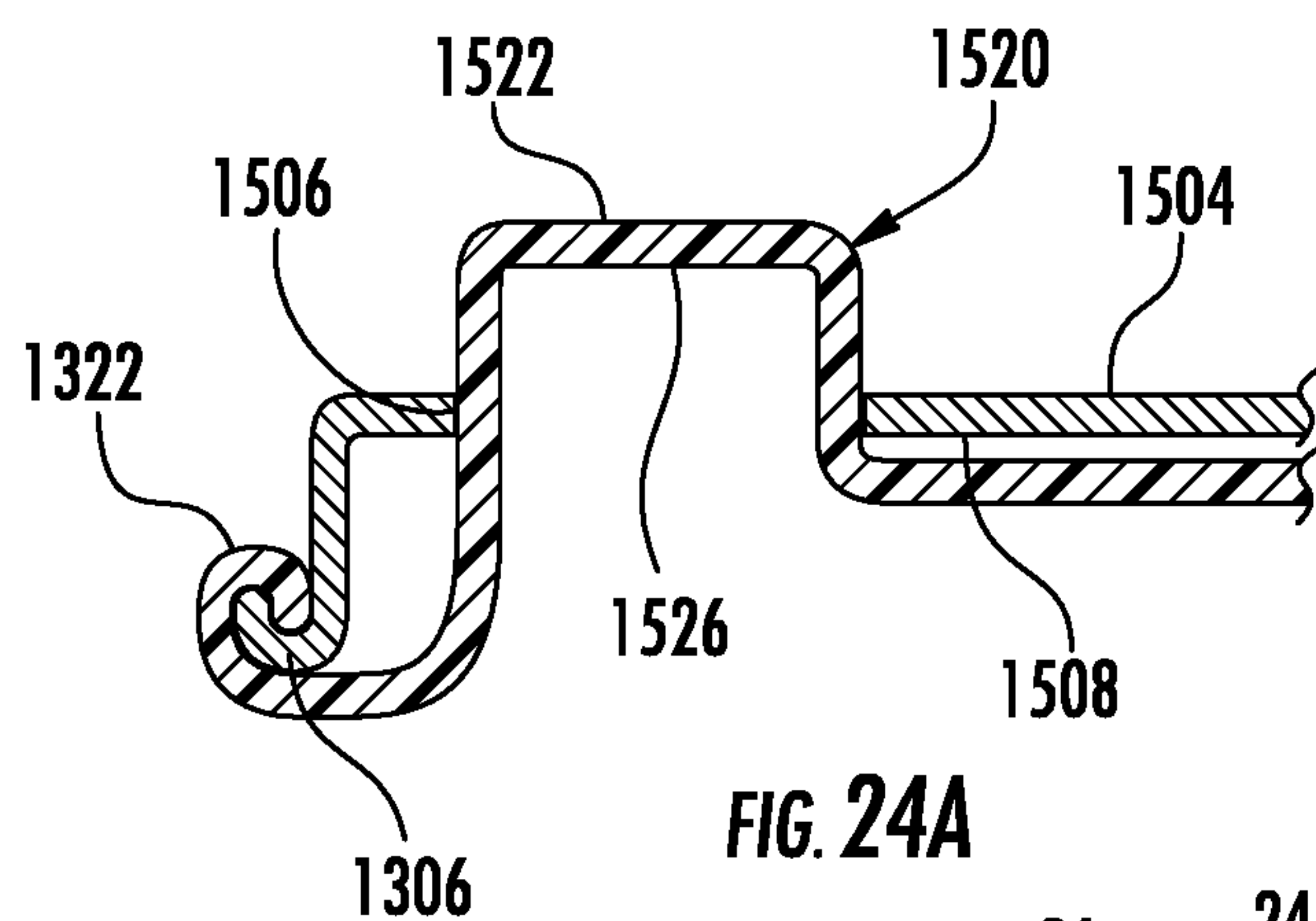


FIG. 24A

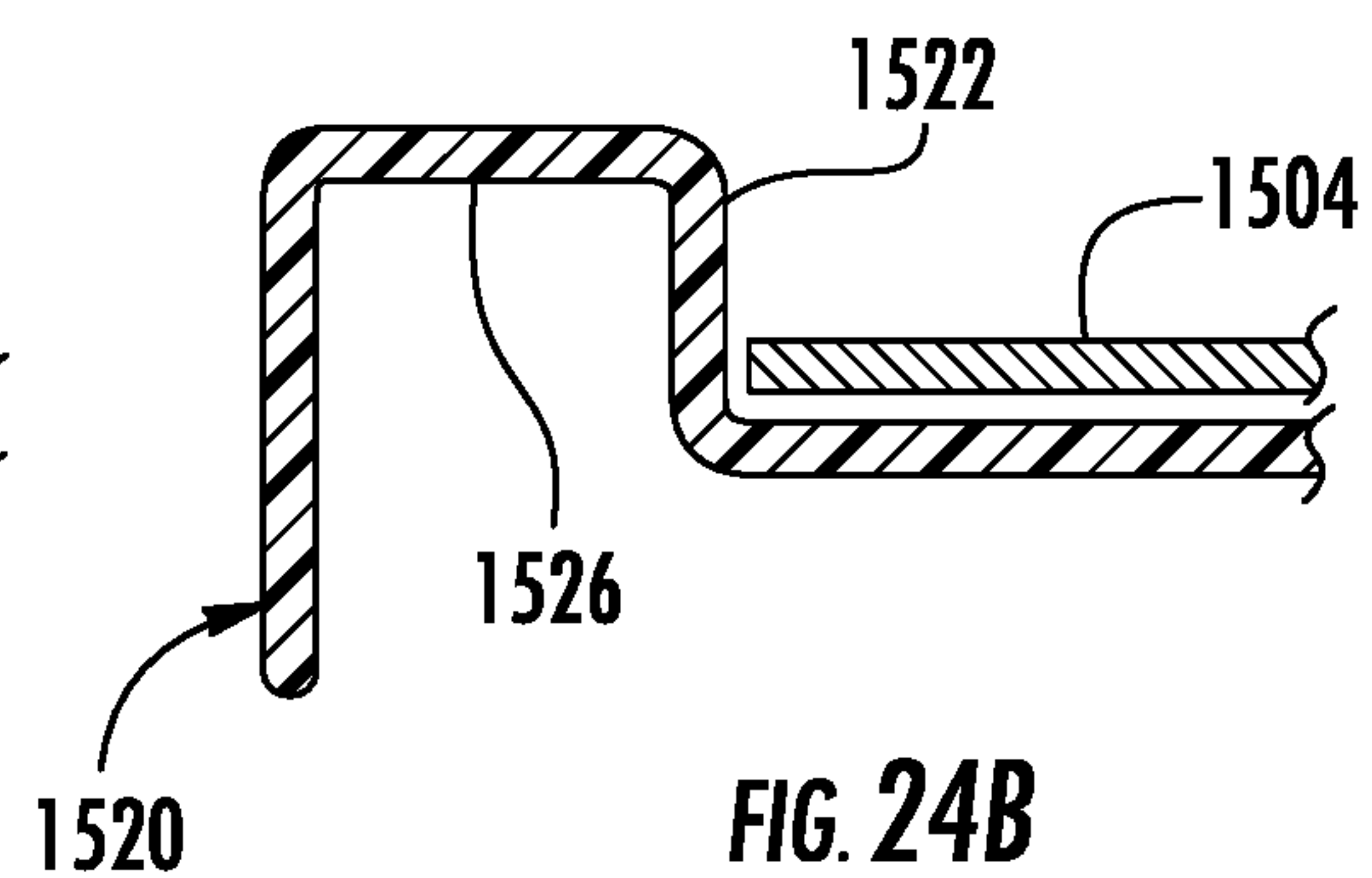


FIG. 24B

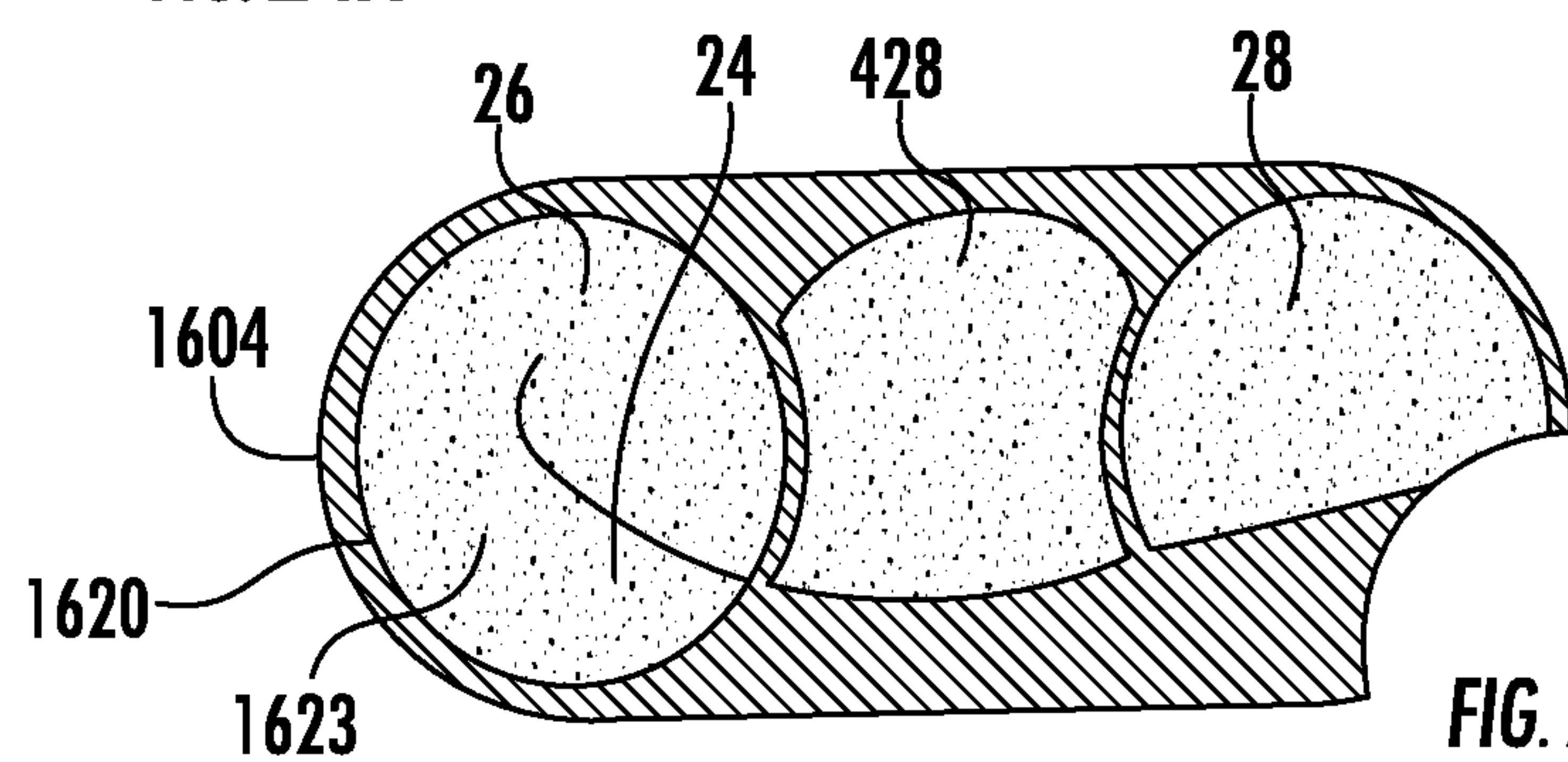


FIG. 24C

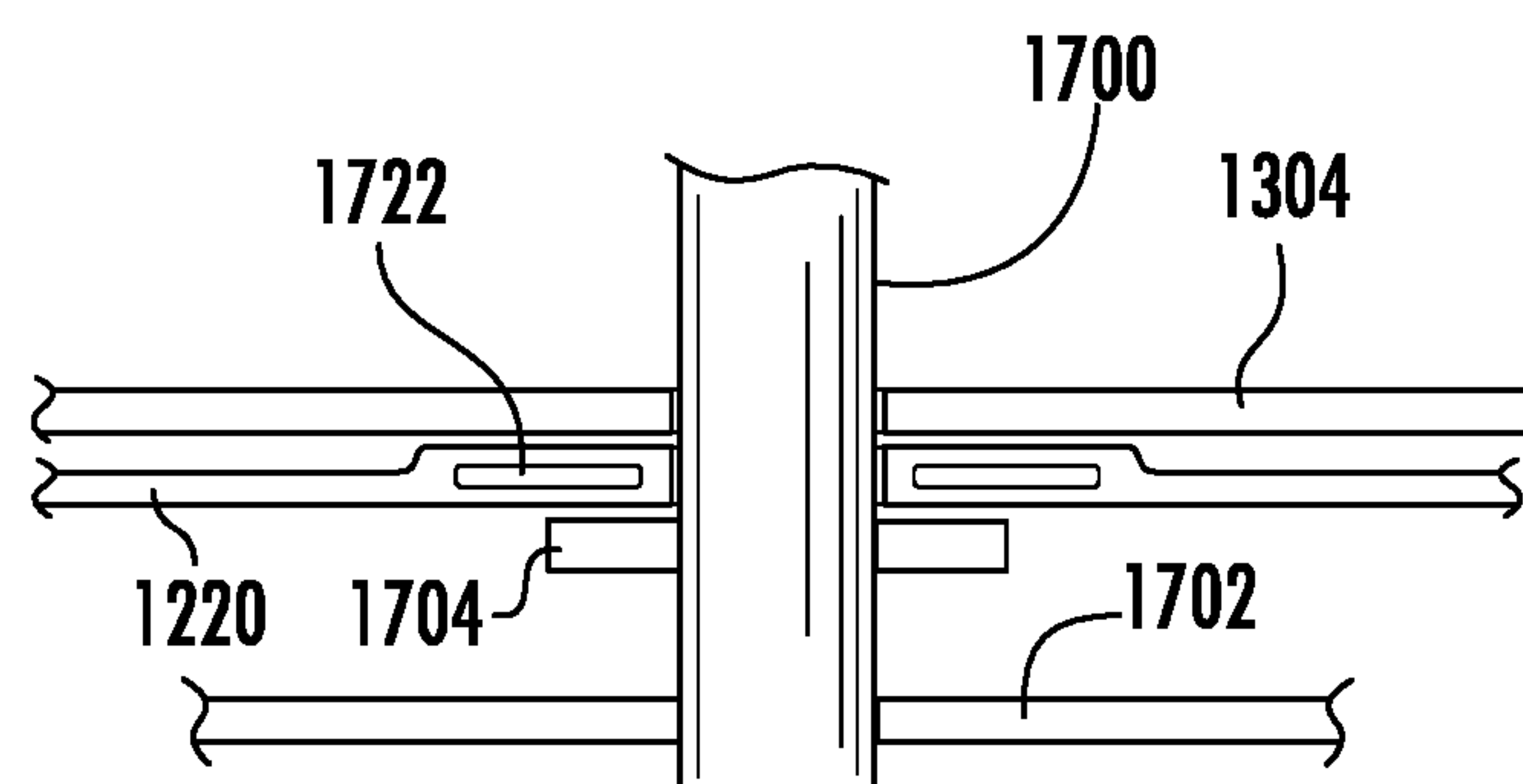


FIG. 25

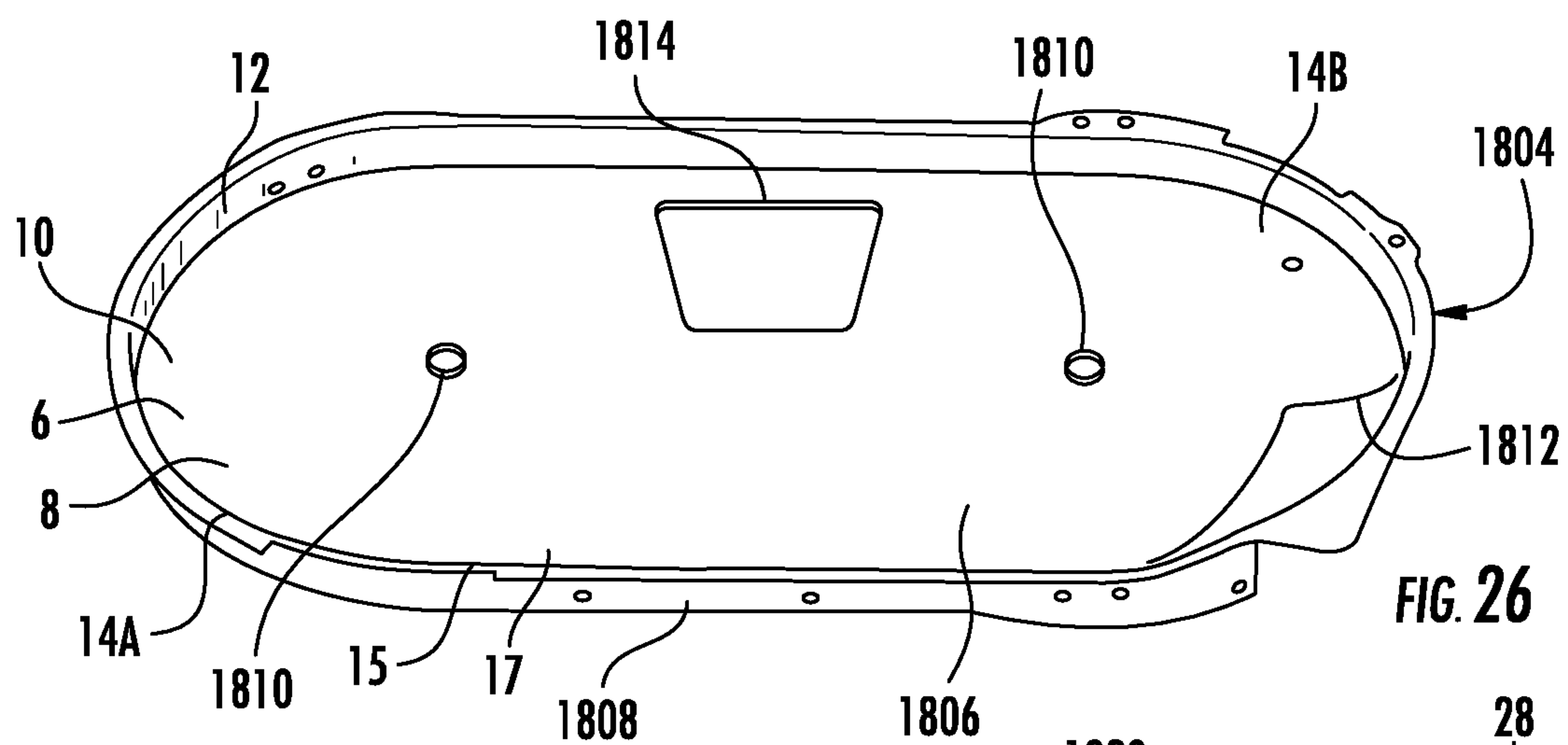


FIG. 26

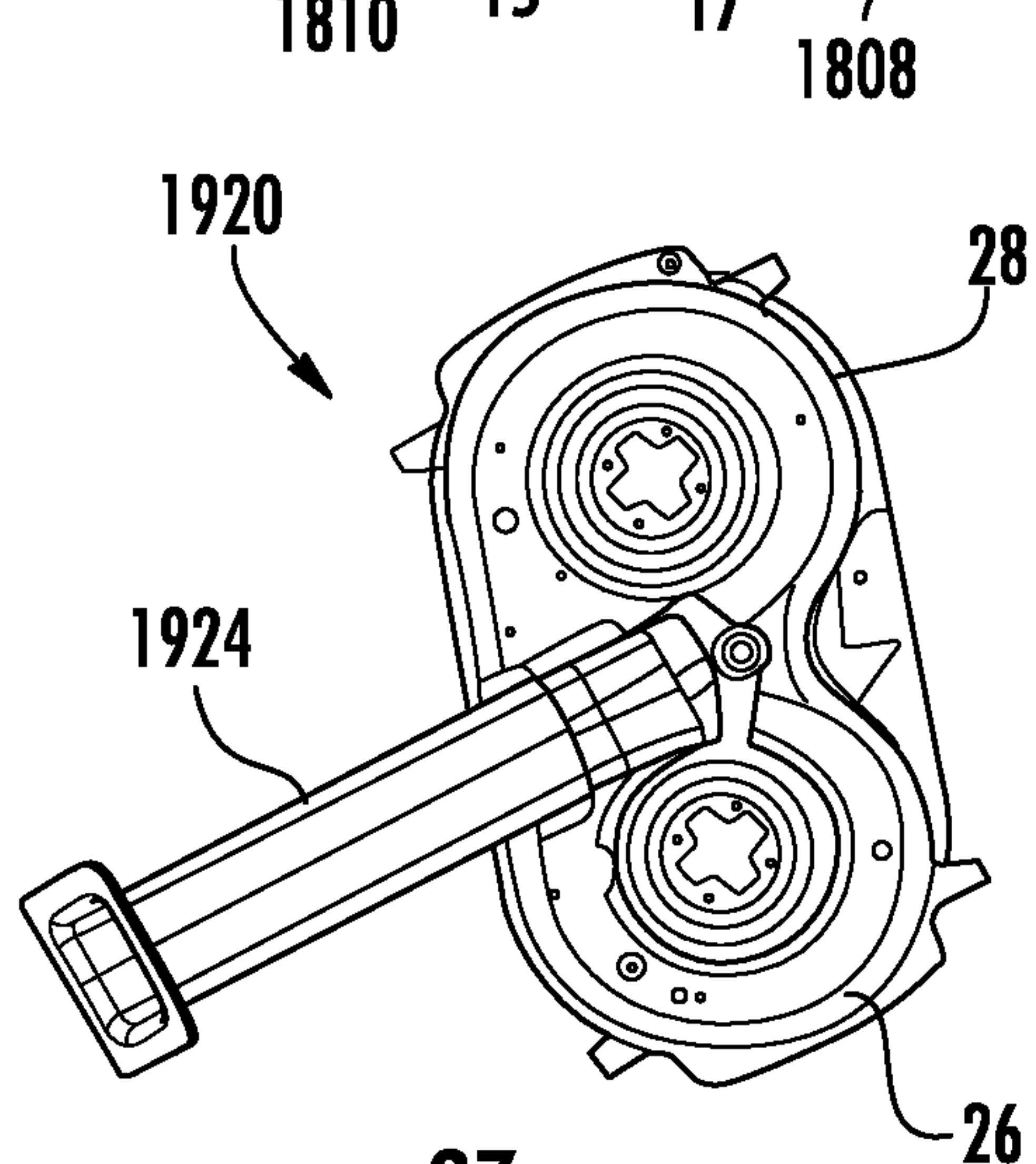


FIG. 27

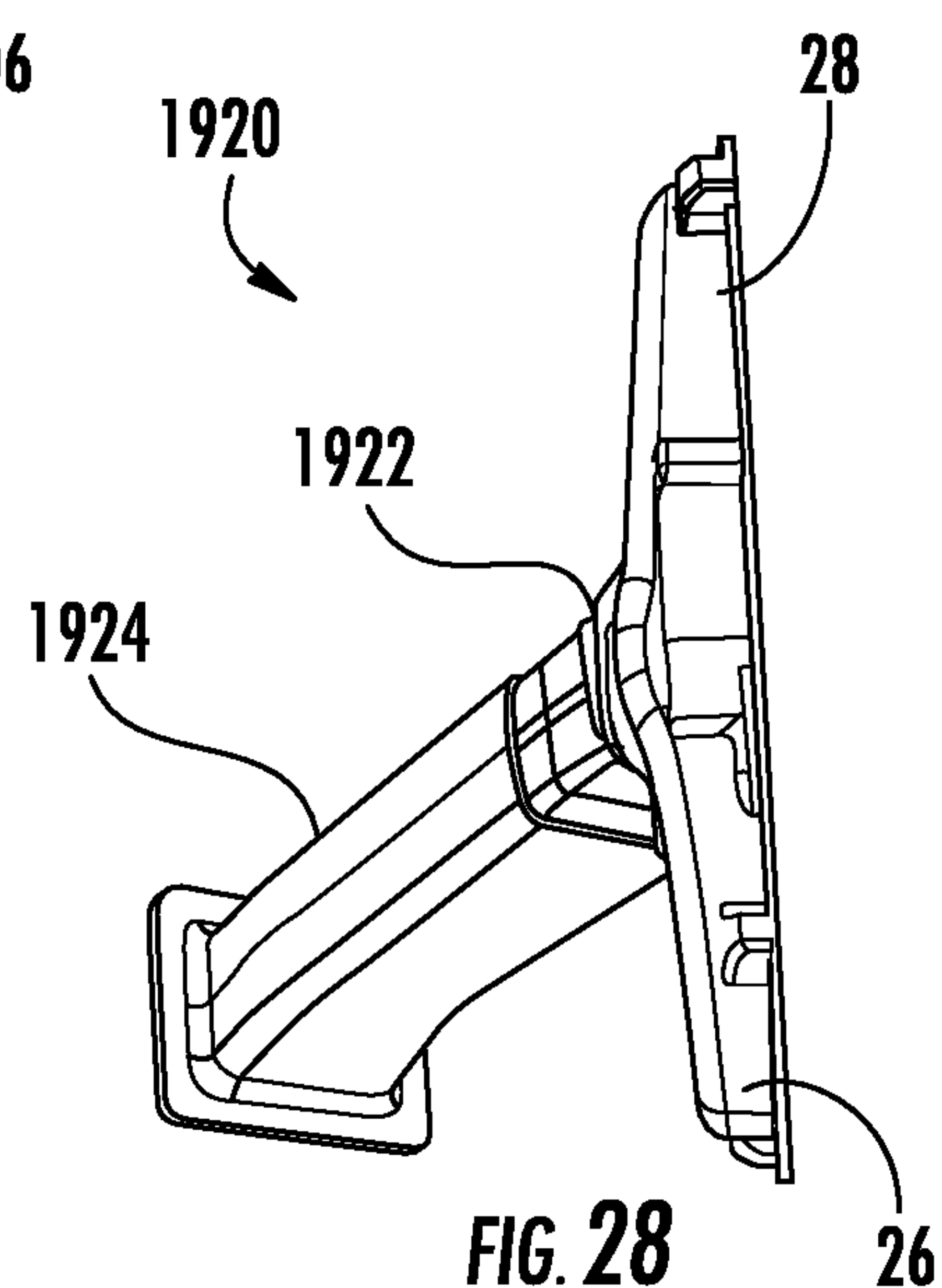


FIG. 28

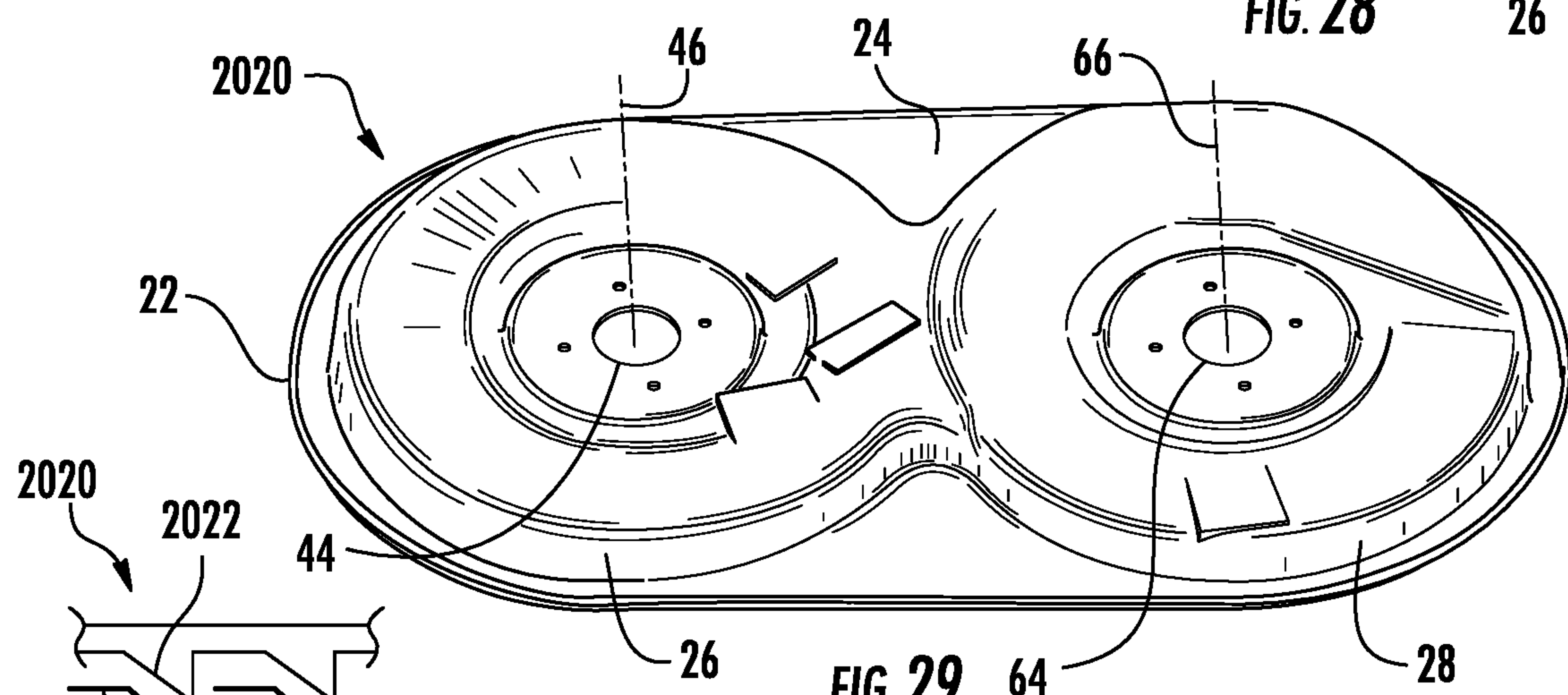


FIG. 29

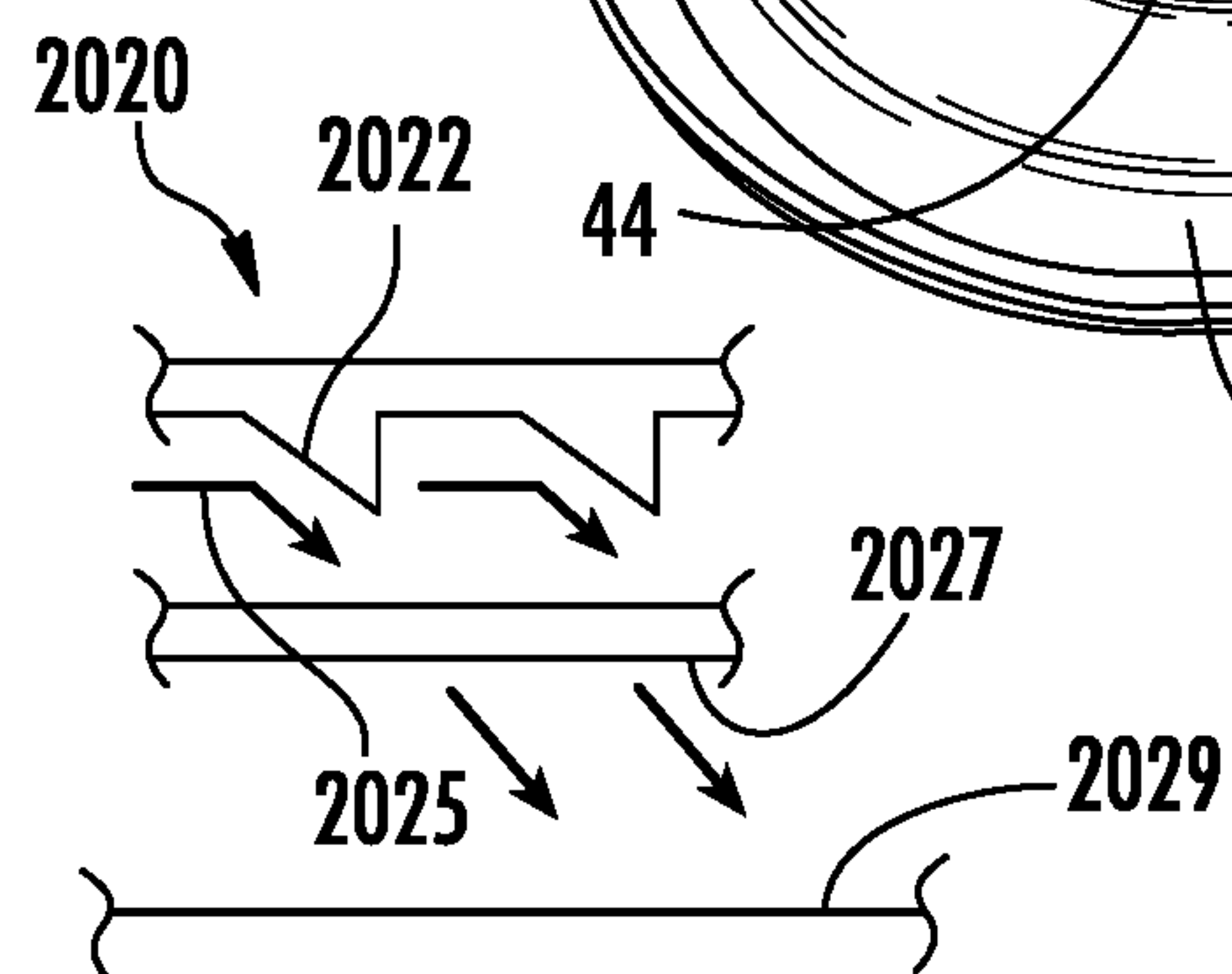
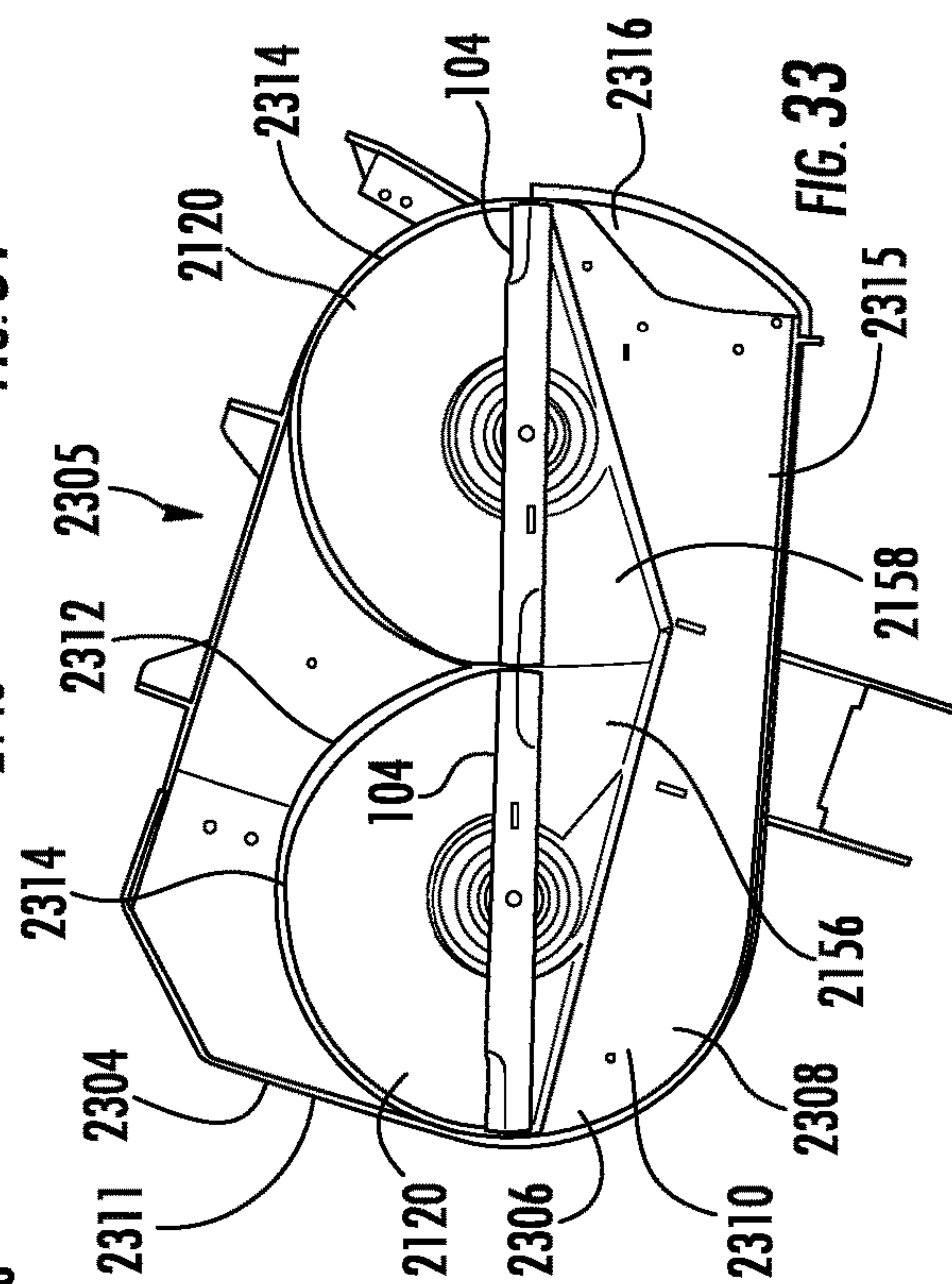
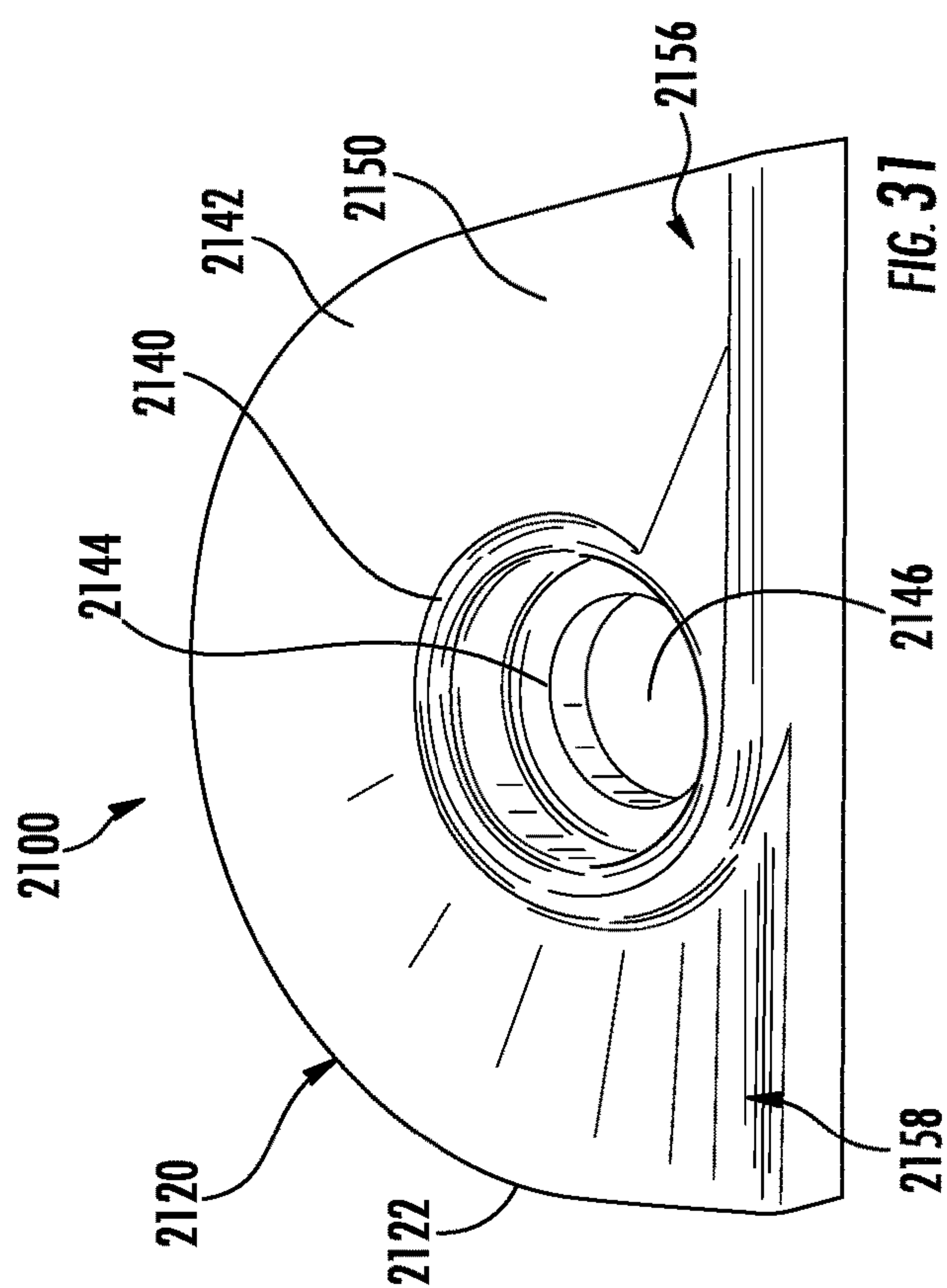
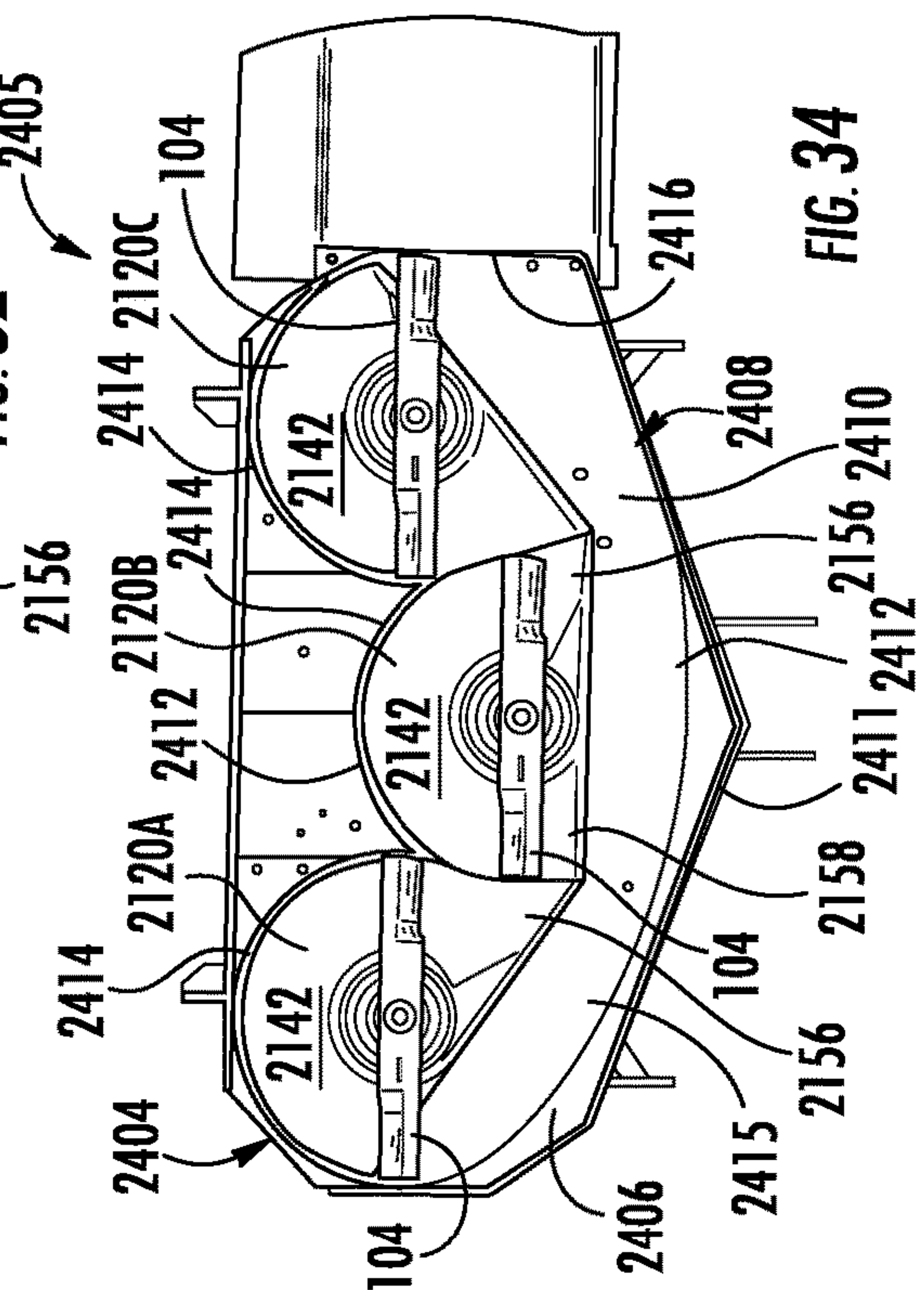
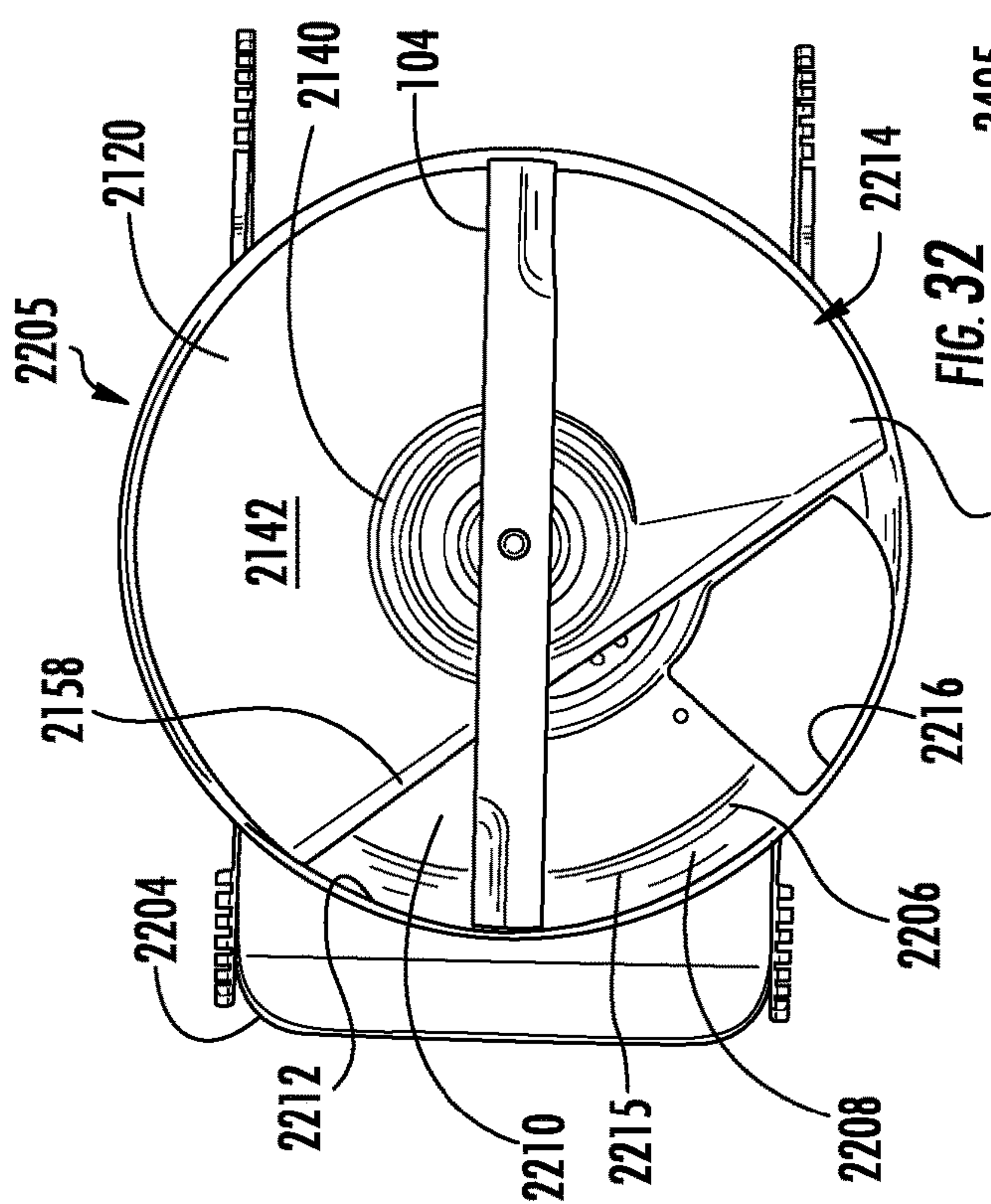
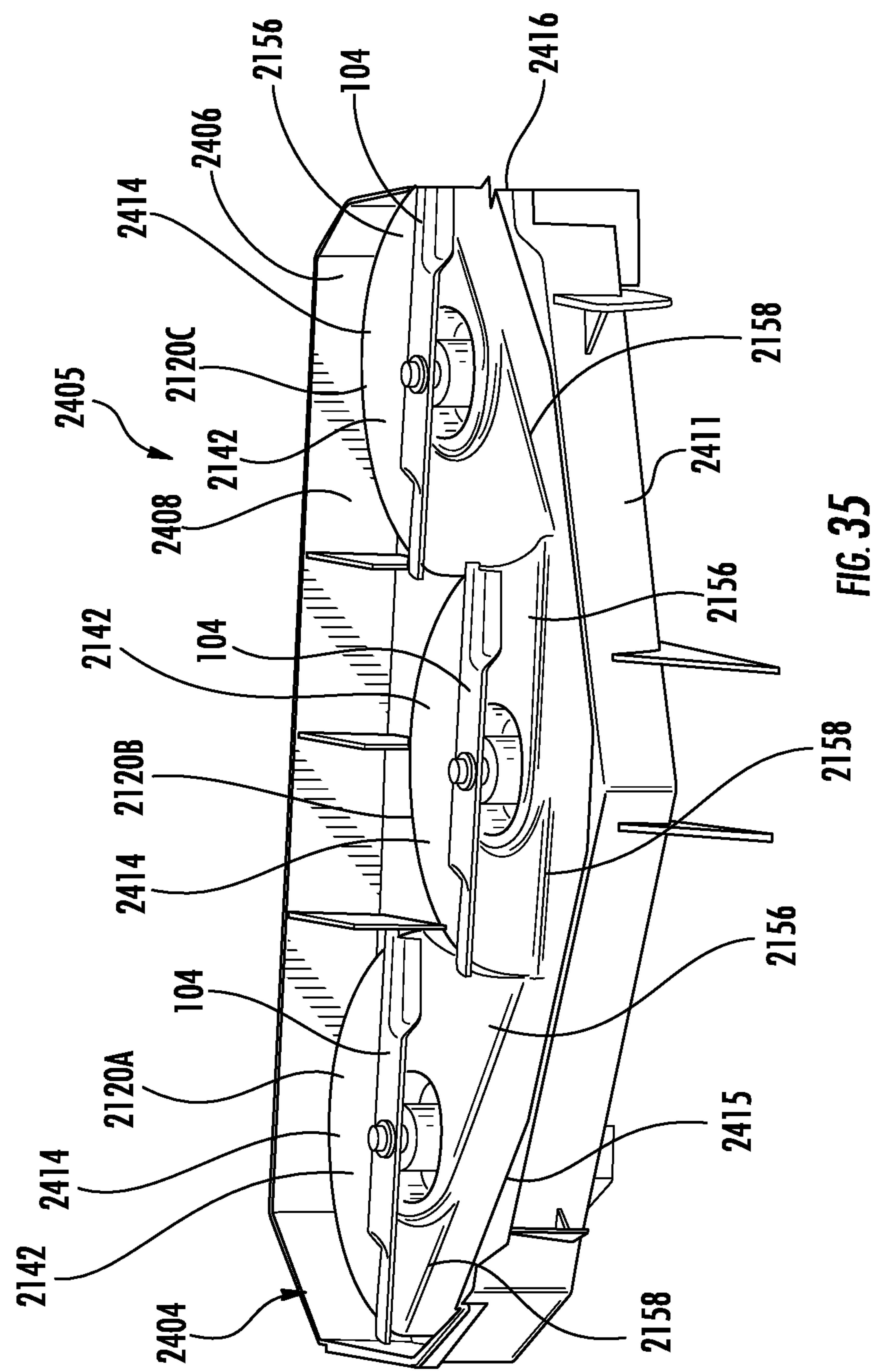


FIG. 30









## 1

**MOWER DECK INSERT****CROSS-REFERENCE TO RELATED PATENT APPLICATIONS**

This application is a continuation of U.S. application Ser. No. 15/430,304, filed Feb. 10, 2017, which is a continuation of PCT/US2015/044730, filed Aug. 11, 2015, which claims priority to U.S. Provisional Application No. 62/035,606, filed on Aug. 11, 2014, all of which are incorporated herein by reference in their entireties.

**BACKGROUND**

Mowers typically include one or more rotating blades and a deck which covers the rotating blades. Mower decks and blades that produce enough air flow for good quality of cut are often noisy and inefficient and require a lot of power to drive the blades.

**SUMMARY**

A first embodiment of the invention relates to a mower deck insert including a first cutting chamber, a second cutting chamber, and a discharge passage extending adjacent to the first cutting chamber and the second cutting chamber. The first cutting chamber includes a first axial scroll extending about a first vertical axis. The first axial scroll includes a first upper surface having a first start region and a first end region. The second cutting chamber includes a second axial scroll extending about a second vertical axis. The second axial scroll includes a second upper surface having a second start region and a second end region. The first start region is vertically lower than the first end region, and the second start region is vertically lower than the second end region.

Another embodiment of the invention relates to a mower including at least one cutting blade operable to rotate about a vertical axis, a mower deck, a mower deck insert coupled to the mower deck. The mower deck insert includes at least one cutting chamber including an axial scroll helically extending about the vertical cutting axis. The axial scroll includes an upper surface having a start region and an end region. The start region is vertically lower than the end region.

Another embodiment of the invention relates to a mower including a mower deck, a first cutting blade operable to rotate about a first vertical axis, a second cutting blade operable to rotate about a second vertical axis, and a mower deck insert coupled to the mower deck. The mower deck insert includes a first cutting chamber and a second cutting chamber. The first cutting chamber includes a first axial scroll helically extending about the first vertical cutting axis, the first axial scroll including a first upper surface having a first start region and a first end region. The second cutting chamber includes a second axial scroll helically extending about the second vertical cutting axis, the second axial scroll including a second upper surface having a second start region and a second end region. The first end region is approximately 240° about the first vertical axis from the first start region.

**BRIEF DESCRIPTION OF THE DRAWINGS**

FIG. 1 is an exploded perspective view of an example mower deck and a deck insert in an inverted orientation.

FIG. 2 is a perspective view of the deck insert of FIG. 1 in an upright orientation.

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FIG. 3 is a sectional view of the deck insert of FIG. 2 taken along lines 3-3.

FIG. 4 is a perspective view of an example cutting unit comprising the inverted deck insert of FIG. 1 within the mower deck and including blades.

FIG. 5 is a top view of an example cutting blade of the cutting unit of FIG. 4.

FIG. 6 is a side view of the cutting blade of FIG. 5.

FIG. 7 is a graph comparing bulk deck airflow as a function of total radial weighted net frontal area for blades for an example cutting unit of FIG. 4 and the prior art cutting unit of FIG. 5.

FIG. 8 is a graph of sound power as a function of total radial weighted net frontal area for the blades of the cutting unit of FIG. 4.

FIG. 9 is a perspective view of an example mower comprising the cutting unit of FIG. 4.

FIG. 10 is a perspective view of another example inverted mower deck.

FIG. 11 is a sectional view of the mower deck of FIG. 10 taken along lines 11-11.

FIG. 12 is a perspective view of an inverted mower deck and cutting blades.

FIG. 13A is a perspective view of an example deck insert mounted to the mower deck of FIG. 12.

FIG. 13B is another perspective view of the deck insert of FIG. 13A mounted to into the inverted mower deck of FIG. 12.

FIG. 13C is a perspective view of the deck insert of FIG. 13A in an inverted orientation.

FIG. 13D is another perspective view of the deck insert of FIG. 13A in an inverted orientation.

FIG. 13E is a perspective view of the deck insert of FIG. 13A in an upright orientation.

FIG. 14A is a perspective view of another example deck insert mounted to into the mower deck of FIG. 12.

FIG. 14B is another perspective view of the deck insert of FIG. 14A mounted to into the inverted mower deck of FIG. 12.

FIG. 14C is a perspective view of the deck insert of FIG. 14A in an inverted orientation.

FIG. 14D is another perspective view of the deck insert of FIG. 14A in an inverted orientation.

FIG. 14E is a perspective view of the deck insert of FIG. 14A in an upright orientation.

FIG. 15A is a perspective view of an example deck insert mounted to into the mower deck of FIG. 12.

FIG. 15B is another perspective view of the deck insert of FIG. 15A mounted to into the inverted mower deck of FIG. 12.

FIG. 15C is a perspective view of the deck insert of FIG. 15A in an inverted orientation.

FIG. 15D is another perspective view of the deck insert of FIG. 15A in an inverted orientation.

FIG. 15E is a perspective view of the deck insert of FIG. 15A in an upright orientation.

FIG. 16A is a perspective view of an example deck insert mounted to into the mower deck of FIG. 12.

FIG. 16B is another perspective view of the deck insert of FIG. 16A mounted to into the inverted mower deck of FIG. 12.

FIG. 16C is a perspective view of the deck insert of FIG. 16A in an inverted orientation.

FIG. 16D is another perspective view of the deck insert of FIG. 16A in an inverted orientation.

FIG. 16E is a perspective view of the deck insert of FIG. 16A in an upright orientation.



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FIG. 17A is a perspective view of an example deck insert mounted to into the mower deck of FIG. 12.

FIG. 17B is another perspective view of the deck insert of FIG. 17A mounted to into the inverted mower deck of FIG. 12.

FIG. 17C is a perspective view of the deck insert of FIG. 17A in an inverted orientation.

FIG. 17D is another perspective view of the deck insert of FIG. 17A in an inverted orientation.

FIG. 17E is a perspective view of the deck insert of FIG. 17A in an upright orientation.

FIG. 18A is a perspective view of an example deck insert mounted to into the mower deck of FIG. 12.

FIG. 18B is another perspective view of the deck insert of FIG. 18A mounted to into the inverted mower deck of FIG. 12.

FIG. 18C is a perspective view of the deck insert of FIG. 18A in an inverted orientation.

FIG. 18D is another perspective view of the deck insert of FIG. 18A in an inverted orientation.

FIG. 18E is a perspective view of the deck insert of FIG. 18A in an upright orientation.

FIG. 19 is a bottom perspective view of another example deck insert.

FIG. 20 is a sectional view of a portion of the deck insert of FIG. 19.

FIG. 21 is a sectional view of another portion of the deck insert of FIG. 19.

FIG. 22 is a fragmentary sectional view of a portion of the deck insert of FIG. 19 supported within an example deck.

FIG. 23A is a fragmentary sectional view of another portion of the deck insert of FIG. 19 supported within the example deck.

FIG. 23B is a fragmentary sectional view of another example deck insert within another example deck.

FIG. 24A is a fragmentary sectional view of another example deck insert supported within another example deck.

FIG. 24B is a fragmentary sectional view of another portion of the deck insert of FIG. 24A.

FIG. 24C is a top view of an example deck serving as a skeleton for supporting another example underlying deck insert.

FIG. 25 is a fragmentary sectional view illustrating one example arrangement supporting an example deck insert.

FIG. 26 is a bottom perspective view of an example deck.

FIG. 27 is a top view of another example deck insert for use with the deck of FIG. 26 for rear bagging.

FIG. 28 is a front perspective view of the deck insert of FIG. 27.

FIG. 29 is a top view of another example deck insert for mulching.

FIG. 30 is a sectional view of a portion of the deck insert of FIG. 29.

FIG. 31 is a bottom view of an example deck insert module.

FIG. 32 is a bottom view of an example deck assembly comprising the module of FIG. 31 mounted beneath another example deck.

FIG. 33 is a bottom view of another example deck assembly comprising a pair of the modules of FIG. 31 mounted beneath another example deck.

FIG. 34 is a bottom view of another example deck assembly comprising three of the modules FIG. 31 beneath another example deck.

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FIG. 35 is a bottom perspective of the deck assembly of FIG. 34.

#### DETAILED DESCRIPTION OF EXAMPLES

FIGS. 1 and 2 illustrate an example mower deck insert 20. FIG. 1 illustrates an underside of mower deck insert 20 withdrawn from mower deck 4 while FIG. 2 illustrates the upright operational orientation of mower deck insert 20 removed from mower deck 4. Mower deck insert 20 is configured to be removably mounted to and held or retained within mower deck 4 so as to surround rotating blades. In other implementations, mower deck insert 20 is permanently mounted or fixed within mower deck 4. In one implementation, mower deck 4 and mower deck insert 20 are for use on a riding mower. In another implementation, mower deck 4 and mower deck insert 20 are for use on a walk-behind self-propelled or push mower. In yet another implementation, mower deck 4 and mower deck insert 20 are for use on a zero turn radius (ZTR) mower. In yet another implementation, mower deck 4 and mower deck insert 20 are for use on a wide area walking mower. As will be described hereafter, mower deck insert 20 protects the underside of mower deck 4 and additionally provides mower deck 4 with a different interior profile that offers greater or equal airflow with less noise and improved efficiency (i.e. less power required to drive the blades). In one implementation, mower deck insert 20 has an interior profile different than the interior profile of the original mower deck, wherein mower deck insert 20 is specifically shaped to optimize side discharge, mulching, or bagging performance. In another implementation, the mower deck insert 20 is specifically shaped to optimize mowing performance in atypical mowing conditions caused by grass type, density, length and moisture content as well as, climate and seasonal changes (e.g. fall leaf cleanup).

Mower deck 4 comprises a deck for being mounted beneath a chassis of a tractor unit so as to enclose a pair of rotating cutting blades. Mower deck 4 has an underside cavity 6 with an interior profile 8. For purposes of this disclosure, the phrase “interior profile” refers to the shape and proportionate size of the interior surfaces that direct airflow produced by the rotation of the cutting blades. In the example illustrated, mower deck 4 comprises a ceiling 10 and sidewalls 12 that form two side-by-side cutting chambers 14A, 14B (collectively referred to as chambers 14), a discharge passage 15 extending alongside cutting chamber 14A and a discharge opening 16 through which cut grass is discharged from chambers 14. Unfortunately, the interior profile of deck 4 may not promote efficient airflow, optimize mowing performance, or reduce noise.

Mower deck insert 20 comprises an additional structure and is either removably or permanently mounted to the underside of deck 4, wherein the structure has an interior profile different than the interior profile of deck 4. In one implementation, mower deck insert 20 is mounted to the underside of deck 4 using mechanical attachment with fasteners, such as screws, bolts, clips, “Christmas trees” and the like, or various fittings. In another implementation, mower deck insert 20 is mounted to the underside of mower deck 4 using a multitude of bonding processes including adhesives and coatings. In yet another implementation, mower deck insert 20 is mounted to the underside of mower deck 4 through welding, latches or other securement mechanism.

In one implementation, mower deck insert 20 is formed from one or more polymeric materials or plastics, providing



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mower deck insert **20** with flexibility and enabling mower deck insert **20** to bend or flex to fit to an existing mower deck **4** without substantially increasing the weight of the cutting unit of the mower. Polymeric forming processes for the mower deck insert **20** could include thermoforming, injection molding, blow molding, rotational molding, and polystyrene foam (or alternative functional equivalent material) coated with a polymeric material. In other implementations, mower deck insert **20** is formed from fiberglass or a stamped metal, such as steel or aluminum. A stamped metal deck insert may be coated or treated with a chemical compound (such as boron nitride) to provide wear resistance and/or reduced friction/anti-stick properties. In yet other implementations, mower deck insert **20** is formed from a foam material or an alternative functional equivalent material (such as wood), wherein at least the underside of the material is coated with a wear resistant coating and/or a low friction/anti-stick coating, such as polytetrafluoroethylene (TEFLON), boron nitride, or polyuria/polyurethane. In addition to providing wear resistance and/or low friction, the coating may also be used to bond the mower deck insert **20** to the mower deck **4**.

In some implementations, deck insert **20** may be employed permanently to the mower deck. In some implementations, deck insert **20** is removably mountable to mower deck **4**, facilitating easy replacement of deck insert **20** when deck insert **20** becomes worn or damaged or when a different interior profile is preferred to optimize performance for a specific application need, such as side-discharging, bagging, mulching, or atypical mowing conditions. Differently configured cutting blades can be used with different interior profiles to provide optimal airflow and/or reduced noise characteristics and/or reduced power consumption characteristics, for a specific application need. A reduced power consumption characteristic is especially desirable if the blade drive system is a battery-powered electric motor. Because deck insert **20** extends on the inside of deck **4**, deck insert **20** protects deck **4** which now serves as a backing, substrate or base structure. In some implementations, sound insulating material can be used between deck insert **20** and deck **4**. Deck insert **20** being of favorable shape for enhanced airflow with less drag and turbulence, reduces unwanted grass buildup on the underside of the mower deck, usually experienced when cutting wet grass. This effect can be enhanced via use of reduced friction/anti-stick coatings in combination with the favorable deck insert **20** shape. Deck insert **20** being of favorable shape for enhanced airflow and vacuum generation reduces or eliminates blow-out from underneath the deck lip, thus improving cut-quality of the mowing unit.

In the example illustrated, mower deck insert **20** comprises a panel or body **22** forming or providing discharge passage **24**, far side cutting chamber **26** and nearside cutting chamber **28**. Discharge passage **24** comprises an elongated channel formed on an underside of body **22** and having a ceiling **34** (appearing as a floor in the inverted mower deck illustrating FIG. 1) bound on opposite sides by sidewalls **36**, **38**. Discharge passage **24** extends tangent to chambers **26**, **30** and terminates at a discharge opening **32**. Discharge passage **24** receives airflow generated by rotating blades within each of chambers **26**, **28**, along with cut grass and other materials. Discharge passage **24** directs the airflow and the cut material through and out discharge opening **32**. In one implementation, discharge opening **32** disperses grass clippings and other cut material. In another implementation of discharge opening **32** directs the grass clippings and other cut material into a collection volume such as a mower bag.

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In the example illustrated in which cut vegetation is dispersed through discharge opening **32**, discharge opening **32** circumferentially extends about axis **72** by at least 75 degrees to discharge the increased rate at which air and cut vegetation are driven by the cutting unit including deck insert **20**.

Far side cutting chamber **26** comprises a cavity formed on the underside of body **22** for receiving and shielding the far side cutting blade (not shown). Far side cutting chamber **26** comprises hub **40** and axial scroll **42**. Hub **40** comprises a portion of body **22** centrally located within chamber **26** and providing a blade mounting portion **44** to rotatably support the far side cutting blade for rotation about far side axis **46**. In the example illustrated, blade mounting portion **44** comprises an aperture extending through hub **40** of body **22** through which a blade shaft or blade bearing assembly extends.

Axial scroll **42** comprises a channel helically extending about axis **46**. Axial scroll **42** comprises an upper surface **50** (appearing as a floor in the inverted deck of FIG. 1) bound by sidewalls **52**, **54**. Upper surface **50** axially scrolls about axis **46** such that scroll **42** is shallowest and such that upper surface **50** is vertically lowest at start region **56** of scroll **42** and such that scroll **42** is the deepest and vertically highest at end region **58**, the junction between scroll **42** and discharge passage **24**. In the example illustrated, upper surface **50** smoothly blends with or ramps into ceiling **34** of discharge passage **24** at end region **58**. In other implementations, the junction between upper surface **50** and region **58** and discharge passage **24** may have a distinctive ramp or step.

In the example illustrated, scroll **42** extends at least 180° and nominally 240° about axis **46**. Upper surface **50** of scroll **42** has scroll height change of less than 2 inches from start region **56** to end region **58**. With such an example, a sufficiently large amount of airflow is produced to move grass clippings and other cut material while at the same time maintaining a low profile for the deck insert **20**, allowing deck insert **20** to better fit beneath a mower chassis. In other implementations, scroll **42** may scroll about axis **46** by other extents and have a different scrolling rate with a different height change.

Near side cutting chamber **28** comprises a cavity formed on the underside of body **22** for receiving and shielding the near side cutting blade (not shown). Near side cutting chamber **28** comprises hub **60** and axial scroll **62**. Hub **60** comprises a portion of body **22** centrally located within chamber **28** and providing a blade mounting portion **64** to rotatably support the far side cutting blade for rotation about near side axis **66**. In the example illustrated, blade mounting portion **64** comprises an aperture extending through hub **60** of body **22** through which a blade shaft or blade bearing assembly extends.

Axial scroll **62** comprises a channel helically extending about axis **66**. Axial scroll **62** comprises an upper surface **70** (appearing as a floor in the inverted deck of FIG. 1) bound by sidewalls **72**, **74**. Upper surface **70** axially scrolls about axis **66** such that scroll **62** is shallowest and such that upper surface **70** is a vertically lowest at start region **76** of scroll **62** and such that scroll **62** is the deepest and vertically highest at end region **78**, the junction between scroll **62** and discharge passage **24**.

In the example illustrated, scroll **62** extends at least 180° and nominally 240° about axis **66**. Upper surface **70** of scroll **62** has scroll height change of less than 2 inches from start region **76** to end region **78**. With such an example, a sufficiently large amount of airflow is produced to move



grass clippings and other cut material while at the same time maintaining a low profile for the deck insert **20**, allowing deck insert **20** to better fit beneath a mower chassis. In other implementations, scroll **62** may scroll about axis **66** by other extents and have a different scrolling rate with a different height change.

Upper surface **70** of scroll **62** feeds into discharge passage **24** at end region **78** at a height below (above in the inverted view of deck insert **20** shown by FIG. **1**) the adjacent portion **80** of ceiling **34** of discharge passage **24**. In the example illustrated, end region **78** of scroll **62** terminates at a shoulder or step **82** which transitions between the lower height of upper surface **70** and the greater height of region **80** of ceiling **34**. At the same time, upper surface **70** of scroll **62** at end region **78** is also at a height below (above in the inverted view of deck insert **20** shown in by FIG. **1**) the height of end region **58** of scroll **42**.

FIG. **3** is a sectional view of the upright mower deck insert **20** of FIG. **2** taken along line **3-3**. As shown by FIG. **3**, because upper surface **70** of scroll **62** at end region **78** feeds into discharge passage **24** at a lower height as compared to upper surface **50** of scroll **42** at end region **48**, airflow and cut material from near side chamber **28**, indicated by dashed arrows **90**, are fed into discharge passage **24** below the airflow and cut material from far side chamber **26**, indicated by solid line arrows **92**. As a result, mower deck insert **20** vertically partitions the cross-sectional area and volume of discharge passage **24**: an upper cross-sectional area or volume for airflow and cut material from far side chamber **26** and a lower cross-sectional area or volume for airflow and cut material from near side chamber **28**. Heavier cut material from far side chamber **26**, due to its longer travel distance, naturally falls into the airflow stream of nearside chamber **28** indicated by arrows **90**, rather than falling out of the airflow stream altogether. Because mower deck insert **20** discharges airflow from chambers **26**, **28** into distinct vertical portions of discharge passage **24**, the airflow streams represented by arrows **92** and **90** from chambers **26** and **28**, respectively, are less likely to interfere with one another. As a result, deck insert **20** provides greater bulk deck airflow, the total airflow exiting deck insert **20** from both chambers **26**, **28** through discharge opening **32**. The greater airflow provided by deck insert **20** more effectively disperses cut materials over the terrain or more effectively propels cut materials into a collection volume carried by the mower. The greater airflow provided by mower deck insert **20** additionally creates a stronger upward vacuum below deck insert **20**, more effectively lifting uncut grass or vegetation for cutting by the cutting blades.

Because the configuration of mower deck insert **20** offers greater airflow for a particular pair of cutting blades being rotatably driven at a particular speed, mower deck insert **20** further facilitates the provision of a mower cutting unit that produces less noise, for a given airflow. FIG. **4** illustrates an example mower cutting unit **100** which produces less noise as compared to existing cutting units producing equivalent amounts of airflow. Mower cutting unit **100** comprises mower deck insert **20**, far side cutting blade **102** and nearside cutting blade **104**. Far side cutting blade **102** and nearside cutting blade **104** are rotatably mounted within chambers **26**, **28** with rotation about axes **46** and **66**, respectively. As compared to mower deck **4**, mower deck insert **20** produces similar bulk airflow through discharge opening **32** with less noise.

FIGS. **5** and **6** illustrate an example cutting blade **104** of cutting unit **100**. In the example illustrated, cutting blade **102** has a same shape and size as cutting blade **104**. In other

implementations, cutting blade **102** may have other configurations than cutting blade **104**. Cutting blade **104** comprises central portion **128**, cutting edges **130** and lift wings **132**. When blade **104** is mounted within chamber **28** of mower deck insert **20**, central portion **128** radially extends from axis **66** (shown in FIG. **4**) and is configured to rotate below hub **60**. Cutting edges **130** are configured so as to rotate beneath scroll **62** while cutting grass or other vegetation. Lift wings **132** extend adjacent and behind cutting edges **130** and are configured so as to displace air and cut material or vegetation to produce airflow about axis **66** in an upwardly angled direction for lift. FIGS. **5** and **6** further illustrate, in broken lines, the configuration of cutting blades **122** and **124** of cutting unit **110**. As shown by FIGS. **5** and **6**, in one implementation, cutting unit **100** comprises cutting blades **102**, **104** with lift wings **132** which are reduced in size as compared to the corresponding lift wings of blades **122**, **124** (shown broken lines). As a result, cutting unit **100** produces less noise.

In one implementation, cutting unit **100** is configured such that cutting blades **102** and **104** have a combined or total net radial weighted frontal area AWFnet such that cutting unit **100** outputs bulk airflow through discharge opening **32** at a rate of at least 600 cubic feet per minute at standard condition (SCFM) at a sound power of less than or equal to 104 decibels (dB). In another implementation, cutting unit **100** is configured such that cutting blades **102** and **104** have a combined or total net radial weighted frontal area such that cutting unit **100** outputs bulk airflow through discharge opening **32** at a rate of at least 700 cubic feet per minute at standard condition (SCFM) at a sound power of less than or equal to 104 decibels (dB), nominally less than or equal to 103.2 dB. In one implementation, cutting unit **100** is configured such that cutting blades **102** and **104** have a combined or net radial weighted frontal area AWFnet and such that cutting unit **100** outputs bulk airflow through discharge opening **32** at a rate of at least 340 SCFM plus 70 times the net radial weighted frontal area AWFnet of blades **102** and **104**.

For purposes of this disclosure, the net radially weighted frontal area comprises the radially weighted frontal area of all the blades of a cutting unit. A radially weighted frontal area of a cutting blade is calculated according to the following:  $AWF(\text{per side}) = \sum b_i h_i / r$ , where  $b$ =increment width,  $i$ =increment,  $h$ =rise or drop of increment and  $r$ =radius of increment, examples of which are illustrated in FIG. **7**. AWFnet is calculated according to  $AWF_{\text{pos}} - AWF_{\text{neg}}$ .

FIGS. **7** and **8** graphically compare output of cutting units comprising mower deck insert **20** having various cutting blades **102**, **104** with different radial weighted net frontal areas with the cutting unit illustrated in FIG. **5** having different radially weighted net frontal areas. In the comparison illustrated in FIGS. **7** and **8**, cutting units **100** and **110** are both two-blade 42 inch decks set at a cut height of 2.5 inches. Such comparison is made when each of the cutting blades of the cutting unit **100** and **110** are rotating at 3130 revolutions per minute.

FIG. **7** graphically depicts the bulk deck airflow in SCFM as a function of total radial weighted net frontal area for cutting unit **100** with mower deck insert **20** and blades **102**, **104** as compared to cutting unit **110** with mower deck **120** and cutting blades **122**, **124**. As shown by FIG. **8**, cutting unit **100** produces bulk deck airflow at a rate of 341.4 SCFM plus a 71.915 multiple of the total radial weighted net frontal area. As shown by FIG. **7**, in one implementation, cutting unit **100** provided with cutting blades **102**, **104** having a total radial weighted net frontal area of only 4 inches squared



produces the same bulk deck airflow as cutting unit **110** requiring cutting blades **122**, **124** to have a total radially weighted net frontal area of at least 11 inches squared.

FIG. **8** graphically depicts the sound power or noise level of cutting unit **100** is a function of the total radial weighted net frontal area of cutting blades **102**, **124**. Sound differences due to the different configurations of decks **20** and **120**, independent of blade configuration are negligible. As shown by FIG. **8**, blades **102**, **104** having reduced lift wings **132**, when employed in cutting unit **100** and producing a bulk deck airflow **150** (shown in FIG. **8**), reduce sound power or noise by at least 3 dB and nominally by at least 4 dB as compared to blades **122**, **124** employed in cutting unit **110** when producing the same bulk deck airflow **150** (shown in FIG. **7**). As shown by FIGS. **7** and **8**, cutting unit **100** with cutting blades **102**, **104** reduces noise while maintaining airflow generation to maintain the vacuum lifting of the uncut vegetation for cutting and to maintain the discharge characteristics for cut vegetation.

FIG. **9** is a perspective view of an example mower **300** comprising cutting unit **100**. As shown by FIG. **9**, mower **300** comprises a riding mower additionally comprising drive **302** and transmission **304**, both of which are schematically illustrated. Drive **302** supplies power to rotate blades **102**, **104** (shown in FIG. **4**) of cutting unit **100**. In one implementation, drive **302** comprises an internal combustion engine. In another implementation, drive **302** comprises a motor, such as an electric motor.

Transmission **304** transmits power or torque from drive **302** to each of cutting blades **102**, **104** of cutting unit **100**. In one implementation, transmission **304** comprises a series of belts and pulleys which transmit torque to each of blades **102**, **104**. In other implementations, transmission **304** may have other configurations such as chain and sprocket or gear train assemblies. As noted above, in other implementations, cutting unit **100** and deck insert **20** may alternatively be utilized in walk behind self-propelled and push mowers, and ZTR units.

As shown by those portions of deck **4** broken away in FIG. **9**, in one implementation, the internal gaps or voids between deck **4** and deck insert **20** are at least partially filled with a filler material **304**, such as an open cell or closed cell foam. In one implementation, once deck insert **20**, has been mounted to deck **4**, a foam material is injected through a provided nozzle opening into the one or more continuous voids between deck **4** and deck insert **20**. The filler material **304** further reduces noise during the operation of mower **300**. In one implementation, the filler material **304** comprises a material that does not bond or adhere to the interior surfaces of deck **4**, allowing the filler material **304** to be peeled away from the underside of deck **4**, when deck insert **20** is being replaced. In yet another implementation, the filler material **304** comprises a material configured to be manually broken apart or chipped away, allowing filler material **304** to be removed from the underside of deck **4** when deck insert **20** is being replaced or is no longer being used. In some implementations, filler material **304** is not added or is added to selected voids or gaps between deck **4** and deck insert **20**.

Although mower deck insert **20** is illustrated for deck insertion into mower deck **4**, mower deck insert **20** is also configured to be mounted into other mower decks having two adjacent or side-by-side cutting chambers **14** leading to a discharge opening **16**. The precise configuration or interior profile of mower deck **4** may have various configurations while still being different than the configuration and interior profile provided by mower deck insert **20**. For example, in

one implementation, mower deck insert **20** may alternatively be mounted into a mower deck **4** that has a continuous square or rectangular underside cavity, omitting projection **17** shown in FIG. **1**. Mower deck insert **20** may alternatively be mounted to into a mower deck **4** having a completely different ceiling shape with differently shaped projections and recesses, wherein mower deck insert **20** so has a different interior profile as compared to that of mower deck **4**.

FIGS. **10** and **11** illustrate mower deck insert **420**, another example implementation of mower deck insert **20**. Mower deck insert **420** is similar to mower deck insert **20** except that mower deck insert **420** comprises three sequentially or serially located or formed cutting chambers for receiving three corresponding rotatably driven cutting blades. Similar to mower deck insert **20**, mower deck insert **420** comprises far side cutting chamber **26** and nearside cutting chamber **28**, described above. Unlike mower deck insert **20**, mower deck insert **420** additionally comprises an intermediate cutting chamber **428**. Those remaining components of mower deck insert **420** which correspond to components of mower deck insert **20** are numbered similarly.

Intermediate cutting chamber **428** is similar to nearside cutting chamber **28** except that intermediate cutting chamber **428** feeds airflow and cut vegetation into a different vertical cross-sectional area or volume of discharge chute to reduce potential airstream interference to increase bulk deck airflow. In the example illustrated, intermediate cutting chamber **428** feeds airflow and cut vegetation into a cross-sectional area of discharge passage **24** that is vertically between ceiling **34** of discharge passage **24** and upper surface **70** of scroll **62** at the junction of scroll **62** with discharge passage **24**.

Intermediate cutting chamber **428** comprises a cavity formed on an underside of body **22** for receiving and shielding an intermediate cutting blade (not shown). Intermediate cutting chamber **428** comprises hub **460** and axial scroll **462**. Hub **460** comprises a portion of body **22** centrally located within chamber **428** and providing a blade mounting portion **464** to rotatably support the intermediate cutting blade for rotation about intermediate axis **466**. In the example illustrated, blade mounting portion **464** comprises an aperture extending through hub **460** of body **22** through which a blade shaft or blade bearing assembly extends.

Axial scroll **462** comprises a channel helically extending about axis **466**. Axial scroll **462** comprises an upper surface **470** (appearing as a floor in the inverted deck of FIG. **11**) bound by sidewalls **472**, **474**. Upper surface **470** axially scrolls about axis **466** such that scroll **462** is shallowest and such that upper surface **470** is a vertically lowest at start region **476** of scroll **462** and such that scroll **462** is the deepest and vertically the highest at end region **478**, the junction between scroll **62** and discharge passage **24**.

In the example illustrated, scroll **462** extends at least 180° and nominally 240° about axis **466**. Ceiling **470** of scroll **462** has scroll height change of less than 2 inches from start region **476** to end region **478**. With such an example, a sufficiently large amount of airflow is produced to move grass clippings and other cut material while at the same time maintaining a low profile for the mower deck insert **420**, allowing mower deck insert **420** to better fit beneath a mower chassis. In other implementations, scroll **462** may scroll about axis **466** by other extents and have a different scrolling rate with a different height change.

Upper surface **470** of scroll **462** feeds into discharge passage **24** at end region **478** at a height below (above in the inverted view of deck insert **420** shown by FIG. **10**) the



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adjacent portion 480 of ceiling 34 of discharge passage 24. In the example illustrated, end region 478 of scroll 462 terminates at a shoulder or step 482 which transitions between the lower height of upper surface 470 and the greater height of region 480 of ceiling 34 of discharge passage 24. At the same time, upper surface 470 of scroll 462 at end region 478 is also at a height below (above in the inverted view of deck 120 shown in by FIG. 10) the height of end region 58 of scroll 42, but above (below in the inverted view of mower deck insert 420 shown in FIG. 10) the height of end region 78 of scroll 62. In one implementation, step 482 of scroll 462 has a height in a range of 0.5 inches and 0.75 inches while step 82 of scroll 62 has a height of at least 1 inch and nominally 1.25 inches. In other implementations, the height or depth of the cross-sectional area of discharge passage 24 may be partitioned or divided amongst the outlets or in regions 58, 78, 478 of the three tangentially located cutting chambers 26, 28, 428, respectively, in other manners. Although mower deck insert 420 is illustrated as including three cutting chambers having axially scrolling upper surfaces, in other implementations, mower deck insert 420 may include greater than three such chambers serially arranged with respect to one another or alternatively arranged tangential to and on both sides of discharge passage 24.

FIG. 11 is a sectional view of the mower deck insert 420 of FIG. 10 taken along line 11-11 with mower deck insert 420 in an upright, operational orientation. As shown by FIG. 11, because upper surface 470 of scroll 462 at end region 478 feeds into discharge passage 24 at a lower height as compared to upper surface 50 of scroll 42 at end region 48, airflow and cut material from intermediate chamber 428, indicated by dashed arrows 490, are fed into discharge passage 24 below the airflow and cut material from far side chamber 26, indicated by solid line arrows 92. Because upper surface 70 of scroll 62 at end region 78 feeds into discharge passage 24 at a lower height as compared to upper surface 470 of scroll 462 at end region 478, airflow and cut material from near side chamber 28, indicated by dashed arrows 90, are fed into discharge passage 24 below the airflow and cut material from intermediate chamber 428, indicated by arrows 490 as well as below the airflow and cut material from far side chamber 26. As a result, mower deck insert 420 vertically partitions the cross-sectional area and volume of discharge passage 24: an upper cross-sectional area or volume for airflow and cut material from far side chamber 26, and intermediate cross-sectional area or volume for airflow and cut material from intermediate chamber 428 and a lower cross-sectional area or volume for airflow and cut material from near side chamber 28. Heavier cut material from far side chamber 26, due to its longer travel distance, naturally falls into the airflow stream of intermediate chamber 428 indicated by arrows 490. Heavier cut material from intermediate chamber 428 naturally falls into the airflow stream of near side chamber 28 indicated by arrows 90.

Because mower deck insert 420 discharges airflow from chambers 26, 28, 428 into distinct vertical portions of discharge passage 24, the airflow streams represented by arrows 92, 90 and 490 from chambers 26, 28 and 428, respectively, are less likely to interfere with one another. As a result, mower deck insert 420 provides greater bulk deck airflow, the total airflow exiting mower deck insert 420 from chambers 26, 28 and 428 through discharge opening 32. The greater airflow provided by mower deck insert 420 more effectively disperses cut materials over the terrain or more effectively propels cut materials into a collection volume carried by the mower. The greater airflow provided by

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mower deck insert 420 additionally creates a stronger upward vacuum below mower deck insert 420, more effectively lifting grass or vegetation for cutting by the cutting blades. Moreover, the greater airflow allows the creation of cutting units that produce the same or greater airflow but with less noise as compared to existing cutting units.

FIG. 12 illustrates an example inverted mower deck 504 for reception of mower deck insert 520 shown in FIGS. 13A-13E. In the example illustrated, mower deck 504 has an underside cavity 506 with an interior profile 508. Interior profile 508 is defined by ceiling 510 and side walls 512. In the example illustrated, sidewalls 512 comprise a linear sidewall portion 513 and an angled sidewall portion 514. Underside cavity 506 has an opening which serves as discharge opening 516. In the example illustrated, deck 504 omits circular cutting chambers, but instead has an open underside volume for supporting three cutting blades 517. In the example illustrated, deck 504 is formed from metal, such as steel plates.

FIGS. 13A-13E illustrate mower deck insert 520, another implementation of mower deck insert 20. FIGS. 13A and 13B illustrate mower deck insert 20 removably or permanently mounted within the mower deck 504. FIG. 13C-13E provide various views of mower deck insert 520. Mower deck insert 520 is similar to Mower deck insert 420 except that intermediate cutting chamber 428 is located forward of cutting chambers 26, 28 and that mower deck insert 520 comprises discharge passage 524 in place of discharge passage 24. As shown by FIG. 12, discharge passage 524 is angled having a first portion or leg 527 extending from end region 58 of scroll 42 and along end region 478 of scroll 462, and a second portion or leg 529 obliquely extending with respect to leg 527 while extending along end portion 78 of scroll 62 to discharge opening 532.

As shown by FIG. 13B which illustrates a deck insert 520 within mower deck 504 from the end of the assembly including discharge opening 516, discharge opening 532 smaller than discharge opening 516 of deck 504, increasing discharge velocity. At the same time, sidewalls 533 of chamber 28 extend partially across opening 516 of deck 504, utilizing the space below deck 504 not utilized by discharge passage 524. As further shown by FIG. 13A, the sidewalls 533 of chambers 26, 28, 428 are each circular or concave, extending along a linear sidewall portion 513, facing away from linear sidewall portion 513. The sidewalls 533 of chamber 428 is spaced further from linear sidewall portion 513 as compared to chambers 26, 28.

As shown by FIG. 13B, deck insert 520 also has an exterior profile, the top surface of deck insert 520 facing the interior surface of deck 504, that is differently shaped and sized than the interior surface of deck 504. As a result, voids 537 are formed between the interior surface of deck 504 and the top or back surface of deck insert 520. In one implementation, such voids 537 remain open. In another implementation, such voids are filled with a filler material, such as the filler material 304 described above.

As shown by FIG. 13C-13E, in the example illustrated, deck insert 520 comprises a single panel formed, such as by vacuum forming or thermoforming, so as to have the illustrated interior profile 540 shown in FIGS. 13E and 13D as well as the exterior profile 542 shown in FIG. 13E. As a result, deck insert 520 has substantially a uniform thickness with the exterior profile 542 substantially mirroring the interior profile 540. In other implementations, deck insert 520 may have varying thicknesses such that exterior profile 542 is different than interior profile 540. In one implementation, exterior profile 542 is configured to match the interior



profile of deck **504** while the interior profile **540** is different than both the exterior profile **542** as well the interior profile of deck **504**.

FIGS. **14A-14E** illustrate deck insert **620**, another implementation of deck insert **20**. Deck insert **620** similar to deck insert **520** except that deck insert **620** comprises mounting collars **630** through which blade supporting spindles **632** (shown in FIG. **14A**) extend. Those remaining components, structure elements of deck insert **620** which correspond to components of deck insert **520** are numbered similarly.

Mounting collars **630** are provided for each of chambers **26**, **28** and **428**. Each of collars **630** includes one or more opening through which fasteners extend for bolting or otherwise fastening spindles **632** to deck insert **620**. In other implementations, mounting collars **630** have other configurations or are omitted.

FIGS. **15A-15E** illustrate deck insert **720**, another implementation of deck insert **20**. Deck insert **720** is similar to deck insert **520** except that deck insert **720** comprises discharge passage **724** instead of discharge passage **524**. Discharge passage **724** is itself similar to discharge passage **524** except the discharge passage **724** follows an arcuate centerline having a concave side that faces sidewalls **533** of chambers **26**, **28**, **428**. The curved shape of discharge passage **724** further enhances the flow of grass clippings and other cut material out discharge passage **724** and ultimately out discharge opening **532**.

FIGS. **16A-16E** illustrate deck insert **820**, another implementation of deck insert **20**. Deck insert **820** is similar to deck insert **720** except that deck insert **820** comprises mounting collars **630** described above. Those remaining components, structure elements of deck insert **820** which correspond to components of deck insert **520** are numbered similarly. In other implementations, mounting collars **630** have other configurations or are omitted.

FIGS. **17A-17E** illustrate deck insert **920**, another example implementation of deck insert **20**. Deck insert **920** is similar to deck insert **620** described above except that deck insert **920** comprises discharge passage **924** in lieu of discharge passage **524** and omits interconnecting web **529** (shown in FIG. **13A**). Discharge passage **924** is similar to discharge passage **524**. As with discharge passage **524**, discharge passage **924** comprises legs **527** and **529** described above. As shown by FIG. **17A**, those portions of deck insert **920** forming the exterior of discharge passage **924** are internally spaced from sidewalls **514** of deck **504** and those portions of deck insert **924** with sidewalls **533** of chambers **26**, **28** and **428** are internally spaced from rear wall **513** of deck **504**. As a result, deck insert **920** is lighter in weight and avoids tolerance concerns when deck insert **920** is mounted within the interior of deck **504**. Variations in width of discharge passage **924** can be used to tailor discharge velocity of cut material.

FIGS. **18A-18E** illustrate deck insert **1020**, another example implementation of deck insert **20**. Deck insert **1020** is similar to deck insert **720** described above except that deck insert **1020** comprises discharge passage **1024** in lieu of discharge passage **524** and omits interconnecting web **529** (shown in FIG. **13A**). Discharge passage **1024** is similar to discharge passage **724**. As with discharge passage **724**, discharge passage **1024** extends along an arcuate centerline having a concave side facing chambers **26**, **28**, **428** and wall **513** of deck **504**. As shown by FIG. **18A**, those portions of deck insert **1020** forming the exterior of discharge passage **1024** are internally spaced from sidewalls **514** of deck **504** and those portions of deck insert **1024** forming sidewalls **533** of chambers **26**, **28** and **428** are internally spaced from

rear wall **513** of deck **504**. As a result, deck insert **1020** is lighter in weight and avoids tolerance concerns when deck insert **1020** is mounted within the interior of deck **504**. Variations in width of discharge passage **924** can be used to tailor discharge velocity of cut material.

FIG. **19** is a bottom perspective view illustrating mower deck insert **1220**, another example implementation of mower deck insert **420**. As with the above described deck inserts, deck insert **1220** is formed from one or more non-metallic materials such as polymers, fiberglass, ceramics, rubbers or the like. Such materials may be in the form of a solid material or layer, a foamed material or layer and/or multiple solid or foamed layers of material laminated to one another. Mower deck insert **1220** is for insertion and mounting to a deck of a mower, within the underside cavity of the deck. In one implementation, mower deck insert **1220** is for mounting within deck **504** shown in FIG. **12**. In other implementations, mower deck insert **1220** may be mounted within other decks or may be modified for mounting within other decks.

Mower deck insert **1220** is similar to mower deck insert **420** in that mower deck insert **1220** has an interior profile shape different than the interior profile or shape of the underside cavity of the deck in which insert **1220** is received. Mower deck insert **1220** is similar to mower deck insert **420** except that mower deck insert **1220** additionally comprises divider walls **1222**, openings **1224**, drag reducing surface treatments **1226** and drag reducing surface treatments **1228**. Those remaining structures are components of insert **1220** correspond to similar components of insert **420** and are numbered similarly.

Divider walls **1222** comprise structures extending downward from the upper surface of deck **1220** towards the underlying ground or terrain. Divider walls **1222** extend between consecutive or adjacent chambers **26** and **428** and between adjacent chambers **428** and **28**. Divider walls **1222** project downwardly towards the underlying terrain by a greater distance than the upper surface or ceilings of the chambers **26**, **28**, **428**. Divider walls **1222** extend adjacent to discharge passage **24** so as to direct airflow from the adjacent chambers **26**, **28**, **428** into and along discharge passage **24**, rather than across the adjacent chamber **26**, **28**, **428**. As a result, divider walls **1222** promote enhanced flow efficiency or better airflow within each of chambers **26**, **28**, **428** and along discharge passage **24**.

Openings **1224** extend from an adjacent divider wall **1222** between adjacent chambers **26**, **28**, **428**. Openings **1224** facilitate overlapping of the cutting swaths of the blade within the respective chambers. In other implementations, openings **1224** may be omitted such as where chambers **26**, **28** and **428** overlap one another in fore and aft directions but do not substantially overlap in a sideways or transverse direction. In such implementations, divider wall **1222** may extend from adjacent discharge passage **24** completely across and between chambers **26**, **28**, **428**.

In the example illustrated, divider walls **1222** comprise triangular shaped, downwardly projecting plateaus. In other implementations, divider walls **1222** may comprise other shapes. In the example illustrated, divider walls **1222** are integrally formed as a single unitary body and homogeneously formed as part of deck insert **1220**. In other implementations, divider walls **1222** may comprise separate structures fastened, snapped or otherwise mounted to an underside of other portions of deck insert **1220**.

Drag reducing surface treatments **1226**, **1228** comprise surface irregularities formed upon the underside surface or ceiling of deck insert **1220**. Surface treatments **1226**, **1228**



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may reduce airflow drag for enhanced performance of deck insert **1220** during mowing. In the example illustrated, drag reducing surface treatments **1226**, **1228** are formed upon an undersurface of deck insert **1220** along the ceilings of each of chambers **26**, **28**, **428**. In yet other implementations, surface treatments **1226**, **1228**, or other drag reducing surface treatments, may be formed upon other ceiling surfaces of deck insert **1220**, such as along the ceiling above the discharge passage. In one implementation, surface treatments **1226**, **1228** are sized, shaped or located so as to not diminish or at least not increase a tendency of grass to clump or collect along such surfaces including surface streams **1226**, **1228**.

As shown by FIGS. **19** and **20**, drag reducing surface treatments **1226** comprise serrations or grooves **1232** formed upon an underside or undersurface of chamber **28**. Grooves **1232** have centerlines that extend along the direction of anticipated airflow. In the example illustrated, grooves **1232** comprise arcuate or circular grooves extending about axis **66** of chamber **28**. In one implementation, each of grooves **1232** has a width of at least 0.125 inches and less than or equal to 0.5 inches, a depth of at least 0.0625 inches and less than or equal to 0.25 inches and a center-to-center pitch of at least 1.5 to 3 times the width of the groove. In other implementations, grooves **1232** may have other configurations. In one implementation, grooves **1232** have a semi-circular cross-sections. In other implementations, grooves **1232** have polygonal cross-section such as square or V-shaped cross-sections.

As shown by FIGS. **19** and **21**, drag reducing surface treatments **1228** comprise craters or dimples **1234** formed upon an underside or undersurface of chamber **26** and chamber **428**. In one implementation, dimples **1234** each have a width or diameter of at least 0.125 inches and less than or equal to 0.5 inches, a depth of at least 0.0625 inches and less than or equal to 0.25 inches and a center-to-center pitch of at least 1.5 to 3 times the diameter of the dimple. In one implementation, dimples **1234** are uniformly dispersed along the undersurface of their respective chambers **26**, **428**. In another implementation, the density of dimples **1234** varies along different portions of the underside of chambers **26**, **428** for enhanced drag reduction where such drag reduction is most beneficial.

In one implementation, insert **1220** is formed from a molded polymer. In such an implementation, grooves **1232** and dimples **1234** are formed during molding of insert **1220**. In yet other implementations, grooves **1232** and/or dimples **1234** or alternatively formed using material removal processes. Although insert **1220** is illustrated as having both types of drag reducing surface treatments **1226**, **1228**, in other implementations, insert **1220** may comprise one or the other of surface treatments **1226**, **1228**. In yet other implementations, insert **1220** may comprise other types of drag reducing surface treatments that breakup airflow to reduce airflow drag along such surfaces.

FIG. **22** is a sectional view illustrating an example coupling and interaction of insert **1220** with a deck, such as deck **1304**. Deck **1304** are similar to deck **504** (shown in FIG. **12** above) except that deck **1304** is specifically illustrated as additionally a lower lip or edge having a rim **1306**. In the example illustrated, rim **1306** forms a hook. In other implementations, rim **1306** forms a horizontal ledge or inclined ledge or lip.

As shown by FIG. **22**, insert **1220** comprises a flange **1322** corresponding to rim **1306**. Flange **1322** is shaped and sized so as to extend over rim **1306** when insert **1220** is mounted or otherwise secured within the underside cavity of deck

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**1304**. In the example illustrated, flange **1322** forms a hook corresponding to the hook provided by rim **1306**. The hooks interact with one another such that insert **1220** wraps about the underside and outside of rim **1306** to protect rim **1306**. At the same time, rim **1306** assists in supporting insert **1220**. In one implementation, insert **1220** is resiliently flexible so as to temporarily deform and snap onto rim **1306** during insertion of insert **1220** into deck **1304**.

In one implementation, an entire outer perimeter of deck **1304** comprises rim **1306** while an entire outer perimeter of insert **1220** comprises flange **1322**. In yet other implementations, insert **1220** comprises a plurality of spaced flanges **1322** which interact with corresponding rims **1306** of deck **1304**. In one implementation, deck **1304** also comprises a plurality of spaced rim portions **1306** corresponding to the location of the plurality of spaced flanges **1322** when insert **1220** is mounted to an insert within deck **1304**.

FIG. **23A** is a sectional view illustrating an example coupling and interaction of another portion of insert **1220** with a deck, such as deck **1304**. As shown by FIG. **23A**, insert **1220** is configured so as to wrap around the downwardly projecting wall of deck **1304** such overlap an outer surface **1406** of deck **1304**, forming a bumper **1422**. In the example illustrated, bumper **1422** extends alongside and parallel to the outer surface of deck **1304**. In one implementation, bumper **1422** extends along the outer wall of chamber **26** along the region indicated by reference numeral **1423** in FIG. **19**. As a result, bumper **1422** protects overlapped portions of deck **1304** which are rubbed against structures during mowing in order to cut closest to such structures with the blade rotating within chamber **26**.

In the example illustrated, bumper **1422** has a thickness  $T$  greater than a thickness  $t$  of the wall forming insert **1222** within deck **1304**. The increased thickness provides enhanced protection. In one implementation, bumper **1422** comprises multiple walls forming a hollow interior **1426**. In one implementation, interior **1426** is empty, reducing the weight of insert **1220**. In one implementation, portions of the walls extending about interior **1426** are resiliently flexible, allowing such walls to resiliently and temporarily collapse into the void within interior **1426** when encountering another structure. In yet another implementation, interior **1426** is at least partially filled with a resiliently compressible material **1428**, such as an open celled or close celled foam. In still other implementations, bumper **1422** may be formed from a single wall of polymeric material having substantially the same thickness is that of the remainder of insert **1220**.

FIG. **23B** is a fragmentary sectional view illustrating deck **1404** and deck insert **1420**, another implementation of deck insert **1220**. Deck **1404** is similar to deck **1304** and deck **504** described above except that deck **1404** comprises at least one opening **1408** extending through the downwardly extending portion **1409** of deck **1404**. In the example illustrated, deck **1404** is formed from one or more layers of non-metallic materials such as one or more layers of a polymer, ceramic, fiberglass or composites thereof. In one implementation, portions of the non-metallic layers of material forming deck **1404** encapsulate or in case metal inserts, such as metal insert **1410**. In other implementations, inserts **1410** may be omitted or deck **1404** may be formed from a metal material.

As further illustrated by FIG. **23B**, in implementations where deck **1404** has a non-metallic body, being formed from one or more layers of a non-metallic material and where deck insert **1420** also has a non-metallic body, formed from one or more layers of a non-metallic material, the



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mower may additionally comprise a rigid metal backbone member **1440** extending between and sandwiched between portions of deck **1404** and insert **1420**. Backbone member **1440** contacts both deck **1404** and insert **1420** while rigidifying and strengthening their respective structures and shapes. In other implementations, backbone member **1440** is omitted.

Deck insert **1420** is similar to deck insert **1220** described above except that deck insert **1420** additionally comprises for bumper portion **1432**. Bumper portion **1432** projects, juts or extends through opening **1408** and beyond opening **1408** horizontally outwardly beyond the outer surface **1411** of downward extending portion **1409** of deck **1404**. In one implementation, bumper portion **1432** projects outwardly beyond outer surface **1411** by at least 0.5 inches and nominally at least 2 inches. In other implementations, bumper portion **1432** extends outwardly beyond surface **1411** by other extends.

In the example illustrated, bumper portion **1432** is hollow, having a hollow interior **1434** in communication with the interior of insert **1420**. In another implementation, the hollow interior **1434** is filled with a gel, foam or other filler material having a greater degree of compressibility or lower density than that of the material forming the walls of insert **1420**. In another implementation, hollow interior **1434** may be omitted and replaced with a honeycomb structure formed from the same material forming insert **1420**. In yet other implementations, bumper portion **1432** is solid.

FIG. **24A** is a sectional view illustrating deck **1504** and insert **1520**, example implementations of deck **1304** and **420** described above. Deck **1504** is similar to deck **1304** and deck **402** except that deck **1504** comprises an opening **1506** extending through deck ceiling **1508**. Opening **1520** received portions of insert **1520**.

Insert **1520** is similar to insert **1220** except that insert **1520** additionally comprises protuberant portion **1522**. Protuberant portion **1522** comprises those portions of insert **1520** that stick out, project or jut upwardly beyond a lower surface of deck **1504** and nominally above the upper surface of deck **1504**. In one implementation, protuberant portion **1522** is prominent with respect to and juts through and above opening **1506**. As shown by FIG. **24B**, in another implementation, insert **1520** extends horizontally beyond a perimeter of deck **1504** then project upwardly above the top of deck **1504** to form protuberant portion **1522** and ceiling **1526**.

Protuberant portions **1522** are integrally formed as a single unitary body and homogenous with portions of insert **1520** that extend below deck **1504** and which form at least portions of the interior profile provided by deck **1520**. In one implementation, protuberant portion **1522** are integrally formed as a single unitary body as part of a single layer that forms both protuberant portion **1520** and the ceiling of at least one of chambers **26**, **28** and **428** (shown in FIG. **19**). In the example illustrated, protuberant portion **1522** is formed as part of a continuous layer that forms a ceiling of discharge passage **24** and each of the chambers provided by the particular insert, such as insert **1520**, wherein portions of the layer projects through opening **1506**.

Protuberant portion **1522** has an underside which forms a ceiling **1526** that forms part of the interior profile provided by insert **1520**. Ceiling **1526** extends at or above and beyond a top surface of deck **1504**. Because protuberant portion **1522** juts or projects above and beyond the top of deck **1504**, the height of ceiling **1526** is not restricted to the vertical distance between the underlying terrain and the underside of

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deck **1504**. As a result, ceiling **1526** may have a greater height, providing a greater volume below ceiling **1526**.

In one implementation, ceiling **1526** of protuberant portion **1522** serves as the ceiling for passage **24**. As a result, those portions of passage **24** provided with ceiling **1526** have a greater cross-sectional area or volume to provide greater space for grass movement and airflow. In one implementation, ceiling **1526** of protuberant portion **1522** is located in the region of passage **24** identified by reference **1423** in FIG. **19**, alongside chamber **26**.

In other implementations, protuberant portion **1522** and its ceiling **1526** may be provided at other portions of insert **1520**. For example, protuberant portion **1522** may additionally or alternatively form part of the ceiling or underside of one or more of channels **26**, **28** and **428**. In one implementation, deck **1504** merely comprises a framework or skeleton, wherein at least a majority and nominally two thirds of the horizontal surface area of deck **1504** is open and wherein the underlying insert **1520** projects through, above and beyond such open areas or regions of deck **1504**.

FIG. **24C** is a top view of an example deck **1604** and the underlying insert **1620**. In the example illustrated, those portions of insert **1620** forming each of chambers **26**, **428** and **28** as well as the far side portion **1623** of passage **24** jut above the upper surface of deck **1604** which serves as a skeleton or supporting framework for insert **1620**. In other implementations, insert **1620** may project above deck **1604** to other extents, wherein the skeletal configuration of deck **1604** may vary depending upon the extent to which insert **1620** projects above deck **1604**.

FIG. **25** is a sectional view illustrating one example arrangement for the support of a deck insert, such as deck insert **1220** or **1520**. As shown by FIG. **25**, the mower additionally comprises a spindle **1700** which supports cutting blade **1702** and a retainer **1704**. In one implementation, retainer **1704** comprises a washer, ring or other structure secured to spindle **1704**. Insert **1220** extends about spindle **1700** and is captured or sandwiched between deck **1304** and retainer **1704**. In one implementation, deck **1304** additionally comprises a strengthening ring or other structure opposite to retainer **1704** and about spindle **1700**.

As further shown by FIG. **25**, in one implementation, insert **1220**, one formed from a molded polymer, encapsulates rigid or strengthening inserts **1722**. In one implementation insert **1722** comprise metal inserts. Such metal inserts provide additional strength and rigidity in selected regions of insert **1220**. In the example illustrated, inserts **1722** are encapsulated within deck insert **1220** in regions about the opening through which spindle **1700** extends, the regions of insert **1220** which are captured between retainer **1704** and deck **1304**. In other implementations, inserts **1722** are fastened, bonded or otherwise secured to deck insert **1220** in other fashions other than through encapsulation. In other implementations, inserts **1722** are provided at additional or alternative locations of deck insert **1220**. In yet other implementations, insert **1722** are omitted.

FIG. **26** is a bottom perspective view of an example deck **1804**. Deck **1804** is similar to deck **4** described above except that deck **1804** lacks complex surface geometries, having the form of an oval basin or pan. In one implementation, deck **1804** is formed from a stamped and deformed metal. In another implementation, deck **1804** is fabricated from sheet metal or plate steel. As shown by FIG. **26**, deck **1804** comprises top **1806**, sidewalls **1808**, blade drive openings **1810**, side discharge opening **1812** and bagging opening **1814**. Blade Drive openings **1810** comprise openings through which shafts or spindles associated with the blades



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to be received within deck **1804** extend. Side discharge opening **1812** comprises an opening at one end of deck **1804** through which clippings are to be discharged to one side of the mower. Bagging opening **1814** comprises an opening through which grass clippings are to be directed to a bag or other clipping collection volume or container. Because deck **1804** includes both side discharge opening **1812** and bagging opening **1814**, deck **1804** may be adapted for side discharge of clippings, bagging of clippings or mulching of clippings through the use of different interchangeable deck inserts.

In one implementation, the mower including deck **1804** is provided with insert **22** (shown and described above with respect to FIGS. **1-4**). In such an implementation, the mower is equipped for side discharge of clippings. In such an implementation, deck insert **22** extends across, includes and covers bagging opening **1814** of riding discharge passage **24** that leads to side discharge opening **1812**.

FIGS. **27** and **28** illustrate deck insert **1920**, a deck insert interchangeable with deck insert **22**. Deck insert **1922** is specifically configured to cooperate with deck **1804** to facilitate rear bagging of clippings. Deck insert **1922** is similar to deck insert **22** described above except that deck insert **1920** omits discharge passage **24** and opening **32** while additionally comprising bagging opening **1922** and chute **1924**. Bagging opening **1922** comprises opening through the ceiling of deck insert **1920** that is in substantial alignment with bagging opening **1814** of deck **1804** when insert **1920** is mounted to an received within the underside cavity of deck **1804**. Bagging opening **1922** is located between chambers **26** and **28**.

Chute **1924** comprises a conduit which extends from bagging opening **1922** through bagging opening **1814** to a clippings containment structure, such as a bag. In one implementation, chute **1924** is integrally formed as a single unitary body with the remainder of deck insert **1920** that is contained below deck **1804**. In another implementation, chute **1924** is releasably mounted to the remainder of deck insert **1920**. In some implementations, chute **1924** is pre-existing as part of the bagging mechanism of the mower, wherein the chute **1924** simply abuts a top of the wall of deck insert **22** when the mower is in a side discharge mode and is not being presently used for bagging of clippings.

FIG. **29** is a top view of deck insert **2020**. Deck insert **2020** is similar to deck insert **20** except that deck insert **2020** is specifically configured for mulching. Deck insert **2020** omits discharge passage **24** and discharge opening **32**. In contrast, deck insert **2020** comprises a continuous layer of material, such as a nonmetal such as a polymer, fiberglass, ceramic or the like, that forms a pair of chambers **26**, **28** in which the cutting blades are rotatably driven to cut grass which is mulched into the underlying uncut grass. The continuous layer of material further comprises a mulching blockage portion **2021**, in the form of a wall, plug or the like, that extends across and blocks discharge opening **1812** of deck **1804**. In some implementations, deck insert **2020** may be used with other decks similar to deck **1804**, but wherein such alternative decks **1804** omit one of openings **1812**, **1814**.

FIG. **30** is a sectional view illustrating a portion of deck insert **2020** as shown by FIG. **30**, the underside of deck insert **2020** comprises kickers, down wings or deflectors **2022** integrally formed as a single unitary body as part of the wall forming insert **2020**. Deflectors **2022** extend along the ceiling of each of chambers **26**, **28**. As indicated by arrows **2025**, deflectors **2022** direct airflow downward across cutting blade **2027** towards the underlying ground or terrain

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**2029**. As a result, grass or clippings is also directed back into the ground **2029** for mulching. In other implementations, deck insert **2020** may omit deflectors **2022**.

FIGS. **31-35** illustrate mower deck insert system **2100**. Mower deck insert system **2100** comprises one or more modules that form a deck insert for a deck. Mower deck insert **2100** comprises a single mower insert module that may be used in a single chamber, single cutting blade mower or that may be combined with other identical modules in multi chambered, multi-cutting blade mowers. FIG. **31** is a bottom perspective view of an example mower deck insert module **2120**. Insert module **2120** is to be mounted to the underside of deck using mechanical attachment with fasteners, such as screws, bolts, clips, "Christmas trees" and the like, or various fittings. In another implementation, mower deck insert module **2120** is configured to be mounted to the underside of mower deck **4** using a multitude of bonding processes including adhesives and coatings. In yet another implementation, mower deck insert module **2120** is configured to be mounted to the underside of mower deck **4** through welding, latches or other securement mechanism.

In one implementation, mower deck insert module **2120** is formed from one or more polymeric materials or plastics, providing mower deck insert module **2120** with flexibility and enabling mower deck insert mother **2120** to bend or flex to fit to an existing mower deck without substantially increasing the weight of the cutting unit of the mower. Polymeric forming processes for the mower deck insert module **2120** could include thermoforming, injection molding, blow molding, rotational molding, and polystyrene foam (or alternative functional equivalent material) coated with a polymeric material. In other implementations, mower deck insert module **2120** is formed from fiberglass or a stamped metal, such as steel or aluminum. A stamped metal deck insert may be coated or treated with a chemical compound (such as boron nitride) to provide wear resistance and/or reduced friction/anti-stick properties. In yet other implementations, mower deck insert module **2120** is formed from a foam material or an alternative functional equivalent material (such as wood), wherein at least the underside of the material is coated with a wear resistant coating and/or a low friction/anti-stick coating, such as polytetrafluoroethylene (TEFLON), boron nitride, or polyurea/polyurethane. In addition to providing wear resistance and/or low friction, the coating may also be used to bond the mower deck insert module **2120** to the mower deck.

In some implementations, deck insert module **2120** may be employed permanently to the mower deck. In some implementations, deck insert mother **2120** is removably mountable to mower deck, facilitating easy replacement of deck insert module **2120** when deck insert mother **2120** becomes worn or damaged or when a different interior profile is preferred to optimize performance for a specific application need, such as side-discharging, bagging, mulching, or atypical mowing conditions. Differently configured cutting blades can be used with different interior profiles to provide optimal airflow and/or reduced noise characteristics and/or reduced power consumption characteristics, for a specific application need. A reduced power consumption characteristic is especially desirable if the blade drive system is a battery-powered electric motor. Because deck insert model **2120** extends on the inside of a deck, deck insert module **2120** protects the deck which now serves as a backing, substrate or base structure. In some implementations, sound insulating material can be used between deck insert **2120** and the deck. Deck insert module **2120** being of favorable shape for enhanced airflow with less drag and



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turbulence, reduces unwanted grass buildup on the underside of the mower deck, usually experienced when cutting wet grass. This effect can be enhanced via use of reduced friction/anti-stick coatings in combination with the favorable deck insert model **2120** shape. Deck insert module **2120** being of favorable shape for enhanced airflow and vacuum generation reduces or eliminates blow-out from underneath the deck lip, thus improving cut-quality of the mowing unit.

In the example illustrated, mower deck insert module **2120** comprises a panel or body **2122** having a perimeter including a linear side portion or vertical wall that forms side of the discharge passage and a curved side portion extending from the linear side portion. Body **2122** further comprises a hub **2140** and axial scroll **2142**. Hub **2140** comprises a portion of body **2122** centrally located to provide a blade mounting portion **2144** for rotatably supporting a cutting blade. In the example illustrated, blade mounting portion **2144** comprises an aperture extending through hub **2140** of body **2122** through which a blade shaft or blade bearing assembly extends.

Axial scroll **2142** comprises a surface **2150** helically extending about axis **2146** and above the linear and curved side portions forming the perimeter of body **2122**. Axial scroll **2142** forms a ceiling **2150** above the cutting chamber. As shown by FIG. 31, in the example illustrated, deck insert model **2120** omits sidewalls about scroll **2142**, instead utilizing sidewalls provided by the overlying deck are deck shell and facilitating use of module **2142** with other modules **2142**. As shown by FIG. 31, deck insert module **2120** omits a discharge passage, instead utilizing portions of the overlying deck or shell to provide the discharge passage, facilitating use of module **2142** with other modules **2142**.

In the example illustrated, axial scroll **2142** axially scrolls about axis **2146** such that scroll **2142** is shallowest and such that upper surface **2150** is vertically lowest at start region **2156** of scroll **2142** and such that scroll **2142** is the deepest and vertically highest at end region **2158**, the junction between scroll **2142** and discharge passage formulation part by the overlying deck or shell. In the example illustrated, upper surface **2150** smoothly blends with or ramps into the ceiling of discharge passage **24** at end region **2158**. In other implementations, the junction between upper surface **2150** at region **2158** and the discharge passage may have a distinctive ramp or step.

In the example illustrated, scroll **2142** extends at least  $180^\circ$  and nominally  $240^\circ$  about axis **2146**. Upper surface **2150** of scroll **2142** has scroll height change of less than 2 inches from start region **2156** to end region **2158**. With such an example, a sufficiently large amount of airflow is produced to move grass clippings and other cut material while at the same time maintaining a low profile for the deck insert model **2120**, allowing deck insert model **2120** to better fit beneath a mower chassis. In other implementations, scroll **2142** may scroll about axis **2146** by other extents and have a different scrolling rate with a different height change.

FIG. 32 illustrates deck insert module **2120** mounted within a single chambered or single cutting blade shell or deck **2204** to form deck assembly **2205**. Mower deck **2204** comprises a deck for being mounted beneath a chassis of a tractor unit so as to enclose a single rotating cutting blade. Mower deck **2204** has an underside cavity **2206** with an interior profile **2208**. In the example illustrated, mower deck **2204** comprises a ceiling **2210** and sidewalls **2212** that form a single cutting chamber **2214**, a discharge passage **2215** extending alongside cutting chamber **2214** and a discharge opening **2216** through which cut grass is discharged from chamber **2214**.

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FIG. 33 illustrates two deck insert modules **2120** mounted within a two chambered or dual cutting blade shell or deck **2304** to form deck assembly **2305**. In the example illustrated, modules **2120** are illustrated as being mounted side-by-side. In the example illustrated, model **2120** are mounted within deck **2304** such that region **2156** of the far side module **2120** (farthest from the discharge opening **2316**) is adjacent region **2158** of the near side module **2120** (closest to discharge opening **2316**). In other implementations, modules **2120** may be spaced from one another. In some implementations, portions of deck **2304** extend between modules **2120** to completely separate modules **2120**.

Mower deck **2304** comprises a deck for being mounted beneath a chassis of a tractor unit so as to enclose a single rotating cutting blade. Mower deck **2304** has an underside cavity **2306** with an interior profile **2308**. In the example illustrated, mower deck **2304** comprises a ceiling **2310**, outer sidewalls **2311** and inner sidewalls **2312** that form two cutting chambers **2314**, a discharge passage **2315** extending alongside cutting chambers **2314** and a discharge opening **2316** through which cut grass is discharged from chambers **2314**. Outer sidewalls **2311** form a perimeter of deck **2304** and define portions of discharge passage **2315**. Inner sidewalls **2312** circumferentially extend about sides of inserts **2120** and define the partial circumferential outer profile of each of cutting chambers **2314**. In some implementations, those portions of outer sidewalls **2311** outside of inner sidewalls **2312** may be omitted. In other implementations, deck **2304** may have other configurations.

FIGS. 34 and 35 illustrate three deck insert modules **2120** (modules **2120A**, **2120B**, **2120C**) mounted within a three chambered or triple cutting blade shell or deck **2404** to form deck assembly **2405**. In the example illustrated, modules **2120** are illustrated as being mounted side-by-side. In the example illustrated, modules **2120** are mounted within deck **2404** such that region **2156** of the far side module **2120A** (farthest from the discharge opening **2416**) is adjacent region **2158** of central module **2120B** while region **2156** of module **2120B** is adjacent region **2158** of near side module **2120C** (closest to discharge opening **2416**). In other implementations, modules **2120** may be spaced from one another. In some implementations, portions of deck **2404** extend between modules **2120** to completely separate modules **2120**.

Mower deck **2404** comprises a deck for being mounted beneath a chassis of a tractor unit so as to enclose a single rotating cutting blade. Mower deck **2404** has an underside cavity **2406** with an interior profile **2408**. In the example illustrated, mower deck **2404** comprises a ceiling **2410**, outer sidewalls **2411** and inner sidewalls **2412** that form three cutting chambers **2414**, a discharge passage **2415** extending alongside cutting chambers **2414** and a discharge opening **2416** through which cut grass is discharged from chambers **2414**. Outer sidewalls **2411** form a perimeter of deck **2304**. Inner sidewalls **2412** circumferentially extend about sides of inserts **2120** and define the partial circumferential outer profile of each of cutting chambers **2314**. In the example illustrated come inner sidewalls **2412** additionally extend alongside discharge passage **2415** two formed sides of discharge passage **2415**. In some implementations, those portions of outer sidewalls **2411** outside of inner sidewalls **2312** may be omitted. In other implementations, deck **2404** may have other configurations.

Although the claims of the present disclosure are generally directed to a more, the present disclosure is additionally directed to the features set forth in the following definitions.



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While the preferred embodiments of the invention have been illustrated and described, it will be appreciated that various changes can be made therein without departing from the spirit and scope of the invention. For example, although different example embodiments may have been described as including one or more features providing one or more benefits, it is contemplated that the described features may be interchanged with one another or alternatively be combined with one another in the described example embodiments or in other alternative embodiments. One of skill in the art will understand that the invention may also be practiced without many of the details described above. Accordingly, it will be intended to include all such alternatives, modifications and variations set forth within the spirit and scope of the appended claims. Further, some well-known structures or functions may not be shown or described in detail because such structures or functions would be known to one skilled in the art. Unless a term is specifically and overtly defined in this specification, the terminology used in the present specification is intended to be interpreted in its broadest reasonable manner, even though it may be used in conjunction with the description of certain specific embodiments of the present invention.

What is claimed is:

1. A mower deck insert comprising:
  - a sidewall;
  - a ceiling;
  - a cavity defined by the ceiling and the sidewall;
  - an first interior profile defined by the ceiling and the sidewall;
  - a mower deck insert within the cavity and comprising:
    - a first cutting chamber comprising a first axial scroll helically extending about a first vertical axis, the first axial scroll comprising a first upper surface having a first start region and a first end region;
    - a second cutting chamber comprising a second axial scroll helically extending about a second vertical axis, the second axial scroll comprising a second upper surface having a second start region and a second end region;
    - a discharge passage extending adjacent to the first cutting chamber and the second cutting chamber; and
    - a second interior profile defined by the first cutting chamber, the second cutting chamber, and the discharge passage; and
    - a gap between the mower deck and the mower deck insert; wherein the second interior profile is different than the first interior profile;
    - wherein the first start region is vertically lower than the first end region, and
    - wherein the second start region is vertically lower than the second end region.
2. The mower deck of claim 1, wherein the second end region is vertically lower than the first end region.
3. The mower deck of claim 2, wherein the first end region fluidly couples the first cutting chamber to the discharge passage.
4. The mower deck of claim 3, wherein the second end region fluidly couples the second cutting chamber to the discharge passage.
5. The mower deck of claim 4, wherein the first axial scroll helically extends at least 180° about the first vertical axis and wherein the second axial scroll helically extends at least 180° about the second vertical axis.
6. The mower deck of claim 1, wherein the first start region is vertically lower than the first end region by less than 2 inches.

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7. The mower deck of claim 6, wherein the second start region is vertically lower than the second end region by less than 2 inches.

8. The mower deck of claim 1, further comprising a discharge opening fluidly coupled to the discharge passage.

9. The mower deck of claim 8, the mower deck insert further comprising a third cutting chamber comprising a third axial scroll helically extending about a third vertical axis, the third axial scroll comprising a third upper surface having a third start region and a third end region; wherein the third cutting chamber is located between the first cutting chamber and the second cutting chamber; and wherein the second interior profile is defined by the third cutting chamber.

10. The mower deck of claim 9, the mower deck insert further comprising a first divider wall and a second divider wall, the first divider wall located between the first cutting chamber and the third cutting chamber, and the second divider wall located between the third cutting chamber and the second cutting chamber.

11. A mower comprising:

- at least one cutting blade operable to rotate about a vertical axis;
- a mower deck comprising a first interior profile;
- a mower deck insert coupled to the mower deck, the mower deck insert comprising:
  - at least one cutting chamber comprising an axial scroll helically extending about the vertical axis, the axial scroll comprising an upper surface having a start region and an end region; and
  - a second interior profile defined by the at least one cutting chamber; and
  - a gap between the mower deck and the mower deck insert; wherein the start region is vertically lower than the end region; and
  - wherein the second interior profile is different than the first interior profile.

12. The mower of claim 11, wherein the at least one cutting chamber further comprises a blade mounting portion and wherein a portion of the at least one cutting blade extends through the blade mounting portion.

13. The mower of claim 12, wherein the at least one cutting blade comprises:

- a central portion;
- one or more cutting edges; and
- one or more reduced size lift wings.

14. The mower of claim 13, wherein the mower deck insert further comprises a discharge passage fluidly coupled to the at least one cutting chamber and a discharge opening fluidly coupled to the discharge passage to discharge airflow externally from the mower deck insert.

15. The mower of claim 14, wherein, during operation of the at least one cutting blade, the discharge opening outputs airflow of at least 600 cubic feet per minute at standard conditions.

16. A mower comprising:

- a mower deck comprising a first interior profile;
- a first cutting blade operable to rotate about a first vertical axis;
- a second cutting blade operable to rotate about a second vertical axis;
- a mower deck insert coupled to the mower deck, the mower deck insert comprising:
  - a first cutting chamber comprising a first axial scroll helically extending about the first vertical axis, the first axial scroll comprising a first upper surface having a first start region and a first end region;

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a second cutting chamber comprising a second axial scroll helically extending about the second vertical axis, the second axial scroll comprising a second upper surface having a second start region and a second end region; and

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a second interior profile defined by the first cutting chamber and the second cutting chamber; and

a gap between the mower deck and the mower deck insert; wherein the first end region is approximately  $240^\circ$  about

the first vertical axis from the first start region; and

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wherein the second interior profile is different than the first interior profile.

**17.** The mower of claim **16**, wherein the second end region is vertically lower than the first end region.

**18.** The mower of claim **16**, wherein the mower deck insert further comprises a discharge passage extending adjacent to the first cutting chamber and the second cutting chamber.

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**19.** The mower of claim **18**, wherein the first end region fluidly couples the first cutting chamber to the discharge passage and wherein the second end region fluidly couples the second cutting chamber to the discharge passage.

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**20.** The mower of claim **19**, wherein during operation the first cutting blade and the second cutting blade output airflow at a sound power of less than or equal to 104 decibels.

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